# BIENNIAL REPORT

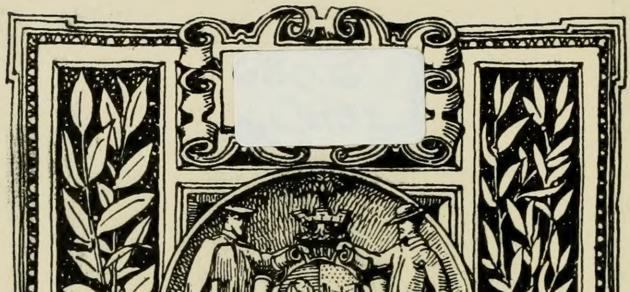
OF THE

# BOARD OF HORTICULTURE

OF THE

## STATE OF OREGON

1899 - 1900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*"ALIS VOLAT PROPRIIS."*

# SIXTH BIENNIAL REPORT

OF THE

# BOARD OF HORTICULTURE

TO THE

TWENTY-FIRST LEGISLATIVE ASSEMBLY

OF THE

## STATE OF OREGON

1900



SALEM, OREGON
W. H. LEEDS, STATE PRINTER
1900

Permanent Exhibit of Oregon Resources—West View—Office State Board of Horticulture, Portland.

# TO THE FRUITGROWER.

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This report is sent to you with the compliments of the board, trusting you may find something of personal interest to you.

For further information, kindly address the commissioner of your district, who will cheerfully answer all communications appertaining to horticultural matter, and who will also visit you, and neighbors, if you so desire.

The commissioner of your district will deem it a special favor if you will inform him of any orchards in your neighborhood which are infected, and the owners thereof counseled with, in order to cleanse and eradicate any insects on their premises.

In order to avoid confusion and simplify matters, we have given only such sprays as we have found by personal experiments to be of any value and yet cover all insects and fungous diseases known to exist in Oregon.

## OFFICERS OF THE BOARD.

E. L. SMITH, - - - - - - - - - - - - President
L. T. REYNOLDS, - - - - - - . - - - - Treasurer
HENRY E. DOSCH, - - - - - - - - - - - Secretary

Office, Portland, Oregon.

## BOARD OF COMMISSIONERS.

STATE AT LARGE.

E. L. SMITH, - - - - - - - - - - - - Hood River

FIRST DISTRICT.

W. K. NEWELL, - - - - - - - - - - - - - Dilley

SECOND DISTRICT.

L. T. REYNOLDS, - - - - - - - - - - - - Salem

THIRD DISTRICT.

A. H. CARSON, - - - - - - - - - - - Grants Pass

FOURTH DISTRICT.

EMILE SCHANNO, - - - - - - - - - - - The Dalles

FIFTH DISTRICT.

JUDD GEER, - - - - - - - - - - - - - - Cove

## DISTRICT BOUNDARIES.

FIRST DISTRICT.

Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop and Tillamook Counties.

SECOND DISTRICT.

Lincoln, Marion, Polk, Benton, Linn and Lane Counties.

THIRD DISTRICT.

Douglas, Jackson, Klamath, Josephine, Coos, Curry and Lake Counties.

FOURTH DISTRICT.

Morrow, Wasco, Gilliam, Crook and Sherman Counties.

FIFTH DISTRICT.

Umatilla, Union, Baker, Wallowa, Malheur, Grant and Harney Counties.

Permanent Exhibit of Oregon Resources—East View—Office State Board of Horticulture, Portland.

# HORTICULTURAL LAW.

AS PASSED BY THE LEGISLATURE, FEBRUARY, 1895.

An Act to amend an act entitled "An act to create a State Board of Horticulture and appropriate money therefor," approved February 25, 1889, and an act amendatory thereof entitled "An act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor,' approved February 25, 1889," approved February 21, 1891, and to protect the horticultural industry in Oregon.

*Be it enacted by the Legislative Assembly of the State of Oregon:*

Section 1. There is hereby created a Board of Horticulture to consist of six members, who shall be appointed by a board, consisting of the Governor, Secretary of State, and State Treasurer. One member of the said Board of Horticulture shall represent the state at large, and one member shall be appointed to represent each of the five districts as hereby created, towit, provided that the commissioner-at-large shall not receive any pay for his services:

First—The first district, which shall comprise the counties of Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop and Tillamook.

Second—The second district, which shall comprise the counties of Marion, Polk, Benton, Lincoln, Linn and Lane.

Third—The third district, which shall comprise the counties of Douglas, Jackson, Klamath, Josephine, Coos, Curry and Lake.

Fourth—The fourth district, which shall comprise the counties of Wasco, Sherman, Morrow, Gilliam and Crook.

Fifth—The fifth district, which shall comprise the counties of Umatilla, Union, Wallowa, Baker, Malheur, Harney and Grant.

Section 2. The members shall reside in the districts for which they are respectively appointed. They shall be selected with reference to their knowledge of and practical experience in horticulture and the industries connected therewith. They shall hold office for the term of four years, and until their successors are appointed and have qualified; but the members of said board now in office shall hold office till the expiration of the term for which they were appointed.

vided. As soon as, in the opinion of any member of the board or the secretary thereof, the danger from such quarantine locality shall have ceased, he may suspend the said quarantine, and shall immediately report the fact to the board, who may confirm such action or may re-establish the said quarantine, in which case it shall not be again suspended but by action of the board.

Section 8. The board, and, in case of necessity during the recess of the board, the member residing in the quarantined district, or the secretary, may appoint such quarantine guardian as may be needed to carry out the provisions of this act, whose duty it shall be to see that the regulations of the board and the instructions of the secretary are enforced and carried out. They shall also report to the board all infractions or violations of said regulations or the law in regard to quarantining, disinfection and destruction of pests. The salary of quarantine guardians shall be fixed by the board at not to exceed $2.00 per day, and shall be paid by the owners of orchards or other places under quarantine, and they may maintain an action therefor before any justice of the peace in any district in which any quarantined locality is wholly or in part located; but in no case shall they have any claim upon the state for such services.

Section 9. The powers conferred in the two preceding sections of this act shall be exercised only in great and imminent danger to the fruit interests of the state, and with the utmost caution and regard for the rights of individuals affected, consistent with the safety and welfare of the fruit interests of the whole state.

Section 10. It shall be the duty of the several members of the board, and of the secretary, under their direction, whenever they shall deem it necessary, to cause an inspection to be made of any orchard, nurseries, trees, plants, vegetables, vines, or any fruit packing-house, storeroom, salesroom, or any other place within their districts, and if found infested with any pests, diseases or fungous growths injurious to fruits, plants, vegetables, trees or vines, or with their eggs or larvæ, liable to spread to other places or localities, or such nature as to be a public danger, they shall notify the owner or owners, or persons in charge of or in possession of such articles, things or places, that the same are so infested, and shall require said persons to eradicate or destroy said insects or pests, or their eggs or larvæ, or to treat such contagious diseases within a certain time, to be specified in said notice. Said

notices may be served upon the person or persons, or any of them, owning, having charge, or having possession of such infested place, article or thing, by any member of the board, or by the secretary thereof, or by any person deputed by the said board for that purpose, or they may be served in the same manner as a summons in an action at law. Such notice shall contain directions for the application of some treatment approved by the commissioners for the eradication or destruction of said pests, or the eggs or larvæ thereof, or the treatment of contagious diseases or fungous growths. Any and all such places, orchards, nurseries, trees, plants, shrubs, vegetables, vines, fruit or articles thus infested are hereby declared to be a public nuisance; and whenever any such nuisance shall exist at any place in the state on the property of any owner or owners upon whom or upon the person in charge or possession of whose property notice has been served as aforesaid, and who shall have failed or refused to abate the same within the time specified in such notice, or on the property of any nonresident, or any property not in the possession of any person and the owner or owners of which cannot be found by the resident member of the board or the secretary, after diligent search within the district, it shall be the duty of the board, or the members thereof in whose district said nuisance shall exist, or the secretary under his or their direction, to cause such nuisance to be at once abated, by eradicating or destroying said insects or pests, or their eggs or larvæ, or by treating or disinfecting the infested or diseased articles. The expense thereof shall be a county charge, and the county court shall allow and pay the same out of the general fund of the county. Any and all sums so paid shall be and become a lien on the property and premises from which said nuisance shall have been removed or abated, in pursuance of this act, and may be recovered by a suit in equity against such property or premises; which suit to foreclose such liens shall be brought in the circuit court of the county where the premises are situated, by the district attorney, in the name and for the benefit of the county making such payments. The proceedings in such cases shall be governed by the same rules, as far as may be applicable, as suits to foreclose mechanics' liens, and the property shall be sold under the order of the court, and the proceeds applied in like manner. The board is hereby invested with the power to cause such nuisances to be abated in a summary manner.

Section 11. It shall be the duty of the secretary to attend

all meetings of the board, and to preserve records of the proceedings, correspondence and actions of the board, to collect books, pamphlets, periodicals, and other documents, containing valuable information relating to horticulture, and to preserve the same; to collect statistics and general information showing the actual condition and progress of horticulture in this state and elsewhere; to correspond with agricultural and horticultural societies, colleges and schools of agriculture and horticulture, and such other persons and bodies as may be directed by the board, and prepare, as required by the board, reports for publication.

Section 12. The board shall, biennially, in the month of January, report to the legislative assembly a statement of its doings, with a copy of the treasurer's report for the two years preceding the session thereof. The members shall receive as compensation their actual expenses while engaged upon the work of the board or the enforcement of the provisions of this act, and shall be allowed $3 a day for the time actually employed.

Section 13. The treasurer shall receive all moneys belonging to the board and pay out the same only for bills approved by it, and shall render annually to the board a statement in detail of all receipts and disbursements.

Section 14. There is hereby appropriated for the uses of the State Board of Horticulture, as set forth in this act, the sum of $4,500 for the year beginning January 1, 1895, and the sum of $4,500 for the year beginning January 1, 1896, out of any moneys in the state treasury not otherwise appropriated, and the Secretary of State shall draw his warrant in favor of the treasurer of the board for said sum upon the State Treasurer.

Section 15. That the fruit and horticultural interests of this state being in urgent need of the protection afforded by this act, an emergency exists, and this act shall take effect from and after its approval by the Governor.

Passed by the house February 11, 1895.

CHARLES B. MOORES,
Speaker of the House.

Passed by the senate February 15, 1895.

JOSEPH SIMON,
President of the Senate.

Approved February 23, 1895.

WILLIAM P. LORD,
Governor.

AN ACT [S. B. 61]

To amend an act entitled "An act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889, and an act amendatory thereof entitled 'An act to amend an act entitled an act to create a State Board of Horticulture and appropriate money therefor,' approved February 25, 1889, approved February 21, 1891, and to protect the horticultural industry in Oregon, and an act amendatory thereof entitled an act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889, and an act amendatory thereof entitled an act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889,' approved February 21, 1891, and to protect the horticultural industry in Oregon," approved February 23, 1895.

*Be it enacted by the Legislative Assembly of the State of Oregon:*

Section 1. That section 1 of an act entitled "An act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889,' and an act amendatory thereof entitled 'An act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889,' approved February 21, 1891, and to protect the horticultural industry in Oregon," be and the same is hereby amended so as to read as follows:

Sec. 1. There is hereby created a Board of Horticulture, to consist of six members, who shall be appointed by a board, consisting of the Governor, Secretary of State, and State Treasurer. One member of the said Board of Horticulture shall represent the state at large and shall be the president and executive officer of the board, and one member shall be appointed to represent each of the five districts as hereby created, to-wit: (1) The first district, which shall comprise the counties of Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop, and Tillamook; (2) the second district, which shall comprise the counties of Marion, Polk, Benton, Lincoln, Linn, and Lane; (3) the third district, which shall comprise the counties of Douglas, Jackson, Klamath, Josephine, Coos, Curry, and Lake; (4) the fourth district, which shall comprise the counties of Wasco, Sherman, Morrow, Gilliam, and Crook; (5) the fifth district, which shall comprise the counties of Umatilla, Union, Wallowa, Baker, Malheur, Harney, and Grant.

Section 2. That section 2 of an act entitled "An act to amend an act entitled 'An act to create a State Board of Horticulture and appropriate money therefor, approved Febru-

ary 25, 1889,' and an act amendatory thereof, entitled 'An act to amend an act entitled an act to create a State Board of Horticulture and appropriate money therefor, approved February 25, 1889,' approved February 21, 1891, and to protect the horticultural industry in Oregon,'' be and the same is hereby amended so as to read as follows:

Sec. 2. The members shall reside in the districts for which they are respectively appointed. They shall be selected with reference to their knowledge of and practical experience in horticulture and the industries connected therewith, and shall be engaged in practical horticulture during their incumbency of the office of commissioner. They shall hold office for the term of four years, and until their successors are appointed and have qualified, unless removed by the appointing board for failure to perform their duties. It shall be the duty of the president to visit, at least once a year, every district, and examine the orchards, nurseries, and work of the district commissioners, and ascertain whether or not the law and regulations of the board are being properly executed. He must personally inspect most of the orchards during the fruit-growing season, see that the regulations of the board regarding spraying are being faithfully executed wherever insects, pests or disease injurious to tree or fruit are to be found. He must visit the principal fruit-shipping points during the shipping season, inspect the fruit shipped, and prevent the shipment of insect and pest-infested fruit. He shall give notice through the public press one week in advance of his visit to each county, giving the time and place of his visit, where he shall receive complaints of fruit-growers and distribute to them printed and oral instructions regarding destruction of pests, and other information, including proper methods of handling, packing and shipping fruits. It shall also be his duty to visit, when possible, if requested by an association or a number of fruitgrowers, the meetings of such associations of fruitgrowers, and aid them in the organization of proper associations beneficial to the growing and marketing of fruits. The president shall preside at all the meetings of the board, and may call special meetings whenever an emergency may require it. He shall make an annual report to the appointing board of the general condition of the fruit interests of the state and success of the commissioners in the work of exterminating pests and executing the law.

Section 15. Inasmuch as the provisions of this act are of

immediate importance to the horticultural interests of this state, this law shall take effect from and after its approval by the Governor.

Approved February 17, 1899.

## AN ACT

[H. B. 238]

To protect the fruit and hop industry in the State of Oregon.

*Be it enacted by the Legislative Assembly of the State of Oregon:*

Section 1. That it shall hereafter be unlawful for any person, firm or corporation owning or operating any nursery, fruit orchard of any kind, hop yards, flower gardens or ornamental trees to throw any cuttings or prunings from any fruit trees, nursery stock, ornamental trees or hop vines into any public road, highway, lane, field or other inclosure, or into any water course of any kind; but shall destroy such cuttings or prunings with fire within thirty days from the time such cuttings or prunings are made.

Section 2. It shall hereafter be the duty of any person, firm or corporation owning or operating any such nursery, fruit orchard, hop yard, flower garden or ornamental trees and knowing such to be infected with any kind of insects, pests or disease to immediately spray or destroy the same in such manner as the fruit commissioner for his district may direct.

Section 3. It shall be unlawful for any person, firm or corporation doing business in the State of Oregon to sell paris green, arsenic, london purple, sulphur or any spray material or compound for spraying purposes, in quantities exceeding one pound, without providing with each package sold a certificate duly signed by the seller thereof guaranteeing the quality and per cent. of purity of said materials.

Section 4. Any person, firm or corporation selling any of the above materials which do not conform with the certificate furnished therewith shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be subject to a fine of not less than twenty-five ($25) dollars nor more than one hundred ($100) dollars.

Section 5. It shall be unlawful for any person, firm or corporation to import or sell any infested or diseased fruit of any kind in the State of Oregon.

Section 6. Every person who packs or prepares for shipment to any point without the state, or who delivers or causes to be delivered to any express agent, or railroad agent, or other person, or to any transportation company or corporation for shipment to any point without the state, any fruit or fruits, either fresh, cured or dried that is infected with insects, pests or diseases injurious to trees, shrubs, plants, fruits or vegetables, is guilty of a misdemeanor.

Section 7. Any person, firm or corporation violating any of the provisions of this act shall be deemed guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not less than twenty-five ($25) dollars nor more than one hundred ($100) dollars.

Section 8. It shall be the duty of the Commissioner of the State Board of Horticulture of the district in which a violation of this act occurs, to present the evidence of the case to the district attorney, whose duty it shall be to prosecute any person guilty of a violation of this act, which prosecution may be brought in any of the justice courts of this state.

Section 9. Inasmuch as the horticultural interests of the state demand immediate attention, this act shall be in full force and effect from and after its approval by the Governor.

Approved by the Governor.

# QUARANTINE REGULATIONS.

At a special meeting of the Oregon State Board of Horticulture, held in Portland, April 2, 1895, all members present, the following regulations were adopted, in accordance with the laws regulating such matters, and are, therefore, binding upon all persons :

Rule 1. All consignees, agents or other persons, shall, within twenty-four hours, notify the quarantine officer of the State Board of Horticulture, or a duly commissioned quarantine guardian, of the arrival of any trees, plants, buds or scions at the quarantine station in the district of final destination.

Rule 2. All trees, plants, cuttings, grafts, buds or scions

imported or brought into the state from any foreign country, or from any of the states or territories, are hereby required to be inspected upon arrival at the quarantine station in the district of final destination; and if any such nursery stock, trees, plants, cuttings, grafts, buds or scions are found to be free of insect pests and fungous diseases, the said quarantine officer or duly commissioned quarantine guardian shall issue a certificate to that effect. And, furthermore, if any of said trees, plants, cuttings, grafts, buds or scions are found infested with insect pests, fungi, blight or other diseases injurious to fruit or to fruit trees, or other trees or plants, they shall be disinfected and remain in quarantine until the quarantine officer of the State Board of Horticulture or the duly commissioned quarantine guardian can determine whether the said trees, plants, cuttings, grafts, buds or scions are free from live injurious insect pests or their eggs, larvæ or pupæ or fungous diseases before they can be offered for sale, gift, distribution or transportation. All persons or companies are hereby prohibited from carrying any trees, plants, cuttings, grafts, buds or scions from without the state to any point within the state beyond the nearest point on its line or course to the quarantine station in the district of ultimate destination; or from any point within the state to any other point therein, until such trees, plants, cuttings, grafts, buds or scions have been duly inspected, and, if required, disinfected as hereinbefore provided; and all such shipments must be accompanied by the proper certificate of the inspecting officer; *provided, however*, that after such persons or company have given the proper officer four days' notice, he or they shall not be required to hold such shipments further, without directions from such officer.

Rule 3. All peach, nectarine, apricot, plum or almond trees, and all other trees budded or grafted upon peach stocks or roots, all peach or other pits, and all peach, nectarine, apricot, plum or almond cuttings, buds or scions raised or grown in a district where the "peach yellows" or the "peach rosette" are known to exist, are hereby prohibited from being imported into or planted or offered for sale, gift or distribution within the State of Oregon.

Rule 4. All trees, plants, cuttings, grafts, buds, scions, seeds or pits arriving from any foreign country found infested with insect pests or their eggs, larvæ or pupæ or with fungi, or other disease or diseases hitherto unknown in this state, are hereby prohibited from landing.

Rule 5. Fruit of any kind grown in any foreign country, or in any of the states or territories, found infested with any insect or insects, or with any fungi, blight or other disease or diseases injurious to fruit or fruit trees, or to other trees or plants, is hereby prohibited from being offered for sale, gift or distribution within the state.

Rule 6. Any boxes, packages, packing material and the like infested by insect or insects, or their eggs, larvæ or pupæ, or by any fungi, blight or other disease or diseases known to be injurious to fruit or to fruit trees, or to other trees or plants, and liable to spread contagion, are hereby prohibited from being offered for sale, gift, distribution or transportation until said material has been disinfected by dipping it in boiling water and allowing it to remain in said boiling water not less than two minutes; such boiling water used as such disinfectant to contain, in solution, one pound of concentrated potash to each and every ten gallons of water.

Rule 7. All trees, plants, grafts, cuttings, buds or scions may be disinfected by dipping in a solution of three-fourths of a pound of whale-oil soap (eighty per cent.) to each and every gallon of water; said whale-oil soap solution shall be kept at a temperature of one hundred to one hundred and fifteen degrees. Said trees, plants, cuttings, grafts, buds or scions shall remain in said solution not less than two minutes. After said trees, plants, cuttings, grafts, buds or scions have been disinfected they shall remain in quarantine fourteen days, unless otherwise directed by the inspecting officer, for subsequent inspection, and if deemed necessary by the quarantine officer of the State Board of Horticulture, or a duly commissioned quarantine guardian, for further disinfection.

Rule 8. All trees, plants, cuttings, grafts, buds or scions may be disinfected by fumigation with hydrocyanic acid gas, as follows: Said trees, plants, cuttings, grafts, buds or scions shall be covered with an air-tight tent or box, and for each and every one hundred cubic feet of space therein, one ounce of C. P. cyanide of potassium (ninety-eight per cent.), one fluid ounce of sulphuric acid, and two fluid ounces of water shall be used. The cyanide of potassium shall be placed in an earthenware vessel, the water poured over the said cyanide of potassium, afterward adding the sulphuric acid, and the tent or box to be immediately closed tightly, and allowed to remain closed for not less than forty minutes. After said trees, plants, cuttings, grafts or scions have been treated with hydro-

cyanic acid gas, as above directed, they shall remain in quarantine for fourteen days, unless otherwise directed by the inspecting officer, for subsequent inspection, and if deemed necessary by a member of the State Board of Horticulture, or the quarantine officer of said board, or a duly commissioned quarantine guardian, for subsequent disinfection.

Rule 9. All trees, plants, cuttings, grafts, buds or scions imported or brought into the state shall be inspected upon arrival at the quarantine station in the district of final destination, and if found infested with any injurious insects or diseases which cannot be destroyed by the remedies required in rules seven and eight of these regulations, are hereby prohibited from being planted or offered for sale, gift or distribution, and shall be proceeded against as a nuisance.

Rule 10. If any person or persons having in their possession trees, plants, cuttings, grafts, buds, scions, seeds or pits infested with an insect or insects, or with any fungi, blight or other disease or diseases injurious to fruit trees, or to any other trees or plants, shall refuse or neglect to disinfect the said trees, plants, cuttings, grafts, buds, scions, seeds or pits as is required by rules seven and eight of these regulations, after having been notified to do so by a member of the State Board of Horticulture, the quarantine officer of said board or a duly commissioned quarantine guardian, the said trees, plants, cuttings, grafts, buds, scions, seeds or pits shall be declared a public nuisance, and shall be proceeded against as provided by law.

Rule 11. Animals known as flying fox, Australian or English wild rabbit, or other animals or birds detrimental to fruit or fruit trees, plants, etc., are prohibited from being brought or landed in this state, and, if landed, shall be destroyed.

Rule 12. Quarantine stations:—

For the first district, comprising the counties of Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop, and Tillamook, shall be Portland. W. K. Newell, quarantine officer, or any member of the board or the secretary thereof.

For the second district, comprising the counties of Marion, Polk, Benton, Linn, Lincoln, and Lane, shall be Salem. L. T. Reynolds, quarantine officer, or any member of the board or the secretary thereof.

For the third district, comprising the counties of Josephine, Coos, Curry, Douglas, Jackson, Lake, and Klamath, shall be

Ashland. A. H. Carson, quarantine officer, or any member of the board or the secretary thereof.

For the fourth district, comprising the counties of Morrow, Wasco, Gilliam, Crook, and Sherman, shall be The Dalles. Emile Schanno, quarantine officer, or any member of the board or the secretary thereof.

For the fifth district, comprising the counties of Umatilla, Union, Baker, Wallowa, Malheur, Grant, and Harney, shall be Milton and Pendleton. Judd Geer, quarantine officer, or any member of the board or the secretary thereof.

At all stations such other quarantine officers as may be from time to time appointed by the board, notice whereof will be given, and complete lists of whom may be obtained from the secretary or any member of the board.

Rule 13. Importers or owners of nursery stock, trees or cuttings, grafts, buds or scions, desiring to have such nursery stock, trees, plants, cuttings, grafts, buds or scions inspected at points other than regular quarantine stations may have such inspection done where required; *provided, however*, that such importers shall pay all charges of inspection; such charges and expenses to be paid before a certificate is granted. Transportation companies or persons and consignees or agents shall deliver and cause to be detained all nursery stock, trees, plants and fruit at one or other of the quarantine stations, for inspection, as provided by the rules and regulations of the board.

Rule 14. The fee for the inspection of apple, pear, plum, peach, nectarine, prune, cherry, apricot, nut-bearing trees and all other trees, shrubs or plants, shall be as follows: Thirty cents per hour, including the time from leaving home, inspection and return home of the inspector, and actual traveling and other expenses. On all fruits, the fee for inspection shall be $1 on any sum up to $35, and $2 on any sum over that amount, and $5 for carload lots.

Rule 15. All persons growing nursery stock, trees and plants for sale, or to be offered for sale, are hereby required to report to the commissioner of the district in which said nursery stock, trees or plants are grown for inspection during the months of September, October or November of each and every year; and the commissioner of such district, or his duly appointed deputy, shall inspect such nursery stock, trees or plants prior to shipment and delivery. When said nursery stock, trees or plants are found by said inspecting officer to be

worthy of a certificate setting forth the freedom of such nursery stock, trees or plants from live, injurious insect pests, their eggs, larvæ, pupæ or fungous diseases, the said inspecting officer shall then issue to the owner or owners of said nursery stock, trees or plants a certificate of inspection. The condition under which this certificate is granted is, that the party or parties receiving such certificate shall be compelled to disinfect by fumigation with hydrocyanic acid gas, as described in Rule 8, all pear and apple trees or other stock grown on apple roots, after lifting the same and before delivery to purchaser or carriers; and in case said fumigation is neglected, said certificate of inspection shall be void and of no effect.

Passed at a meeting of the State Board of Horticulture at Portland, Oregon, April 3, 1895, and amended at a regular meeting of the State Board of Horticulture at Salem, Oregon, October 15, A. D. 1895.

Henry E. Dosch, Secretary, is hereby appointed quarantine officer for the Port of Portland.

PORTLAND, Oregon, April 10, 1900.

*To the Governor, Secretary of State, and State Treasurer—*

SIRS: In accordance with the law passed at the last session of the legislature, I hereby present my annual report as President of the State Board of Horticulture:

## GENERAL CONDITIONS.

This state contains many hundred old orchards, mostly small home places, the fruit from which has been used for home consumption and local markets. Since pests and diseases have been increasing, these orchards have been neglected, and as the soil is being drained of its fertility, most of the old places have become little else than breeding places for insects and fungi that endanger any commercial or well-kept orchard in their vicinity. The fruit from most of these unkept trees is of little value even for home consumption, excepting cherries, and where these old trees have been found infested in proximity to clean orchards, the commissioners have enforced the law, and had them cleaned or taken out entirely. From now on a more vigorous policy must be pursued, and all unkept places must be trimmed and kept clean, or taken out entirely.

### NURSERIES.

Several nurseries were in bad condition, being infested with canker, scale and aphis. Some have been condemned and cleaned by burning, and all diseased places have been cleansed and put in good shape, and others have cleaned up and retired from the business.

The low price at which nursery stock had been selling made the business unprofitable, and more than half of the people engaged in the work have retired during the past few years.

The past year has seen a very healthy revival of the nursery business, and good, clean stock, up to date in varieties, has been in good demand at fair prices. Washington, Idaho, Montana and California have been buying largely of Oregon nurserymen during the past year, and some shipments have been made to the Orient.

### APPLE CANKER.

The worst difficulty found with nursery stock was that much of it was infested with canker, without the knowledge of the nurseryman. By tracing up the disease found in many young orchards, it was discovered that many young apple trees had become infested while in the nursery, sometimes coming from cuttings, but generally from cankered trees in the vicinity of the nursery. As the spores are blown about, and can be carried as far as half a mile, and perhaps more, it is of the utmost importance that all old trees near to nurseries should be carefully sprayed and the disease killed. This disease has been widely distributed throughout the state, and in all parts of Western Oregon its growth is so rapid as to endanger the success of apple growing. It seems to thrive equally well in all parts of Western Oregon. In Eastern Oregon, in the dryer regions, it does not seem to be so injurious; but as it is found doing well in the vicinity of the timber line of Eastern Washington there is danger of its extending over Eastern Oregon.

Prof. A. B. Cordley, of the Oregon Experiment Station, has been doing some valuable work for the state in connection with this pest, and in his further researches will no doubt find an efficient method for mastering it. For the present the most important work is to keep it out of the nursery stock.

### SAN JOSE SCALE.

This insect is to be found now in almost every orchard section of the state, and in many places is doing serious damage, having in some places entirely ruined good orchards in two years from its first appearance. It is to be found generally in most of the towns, where it attacks not only fruit trees and berry bushes, but ornamental trees and shrubbery as well.

Much good work has been done by the commissioners this year in enforcing regulations in regard to spraying in the dooryards of the principal towns and cities. A continued and more rigid enforcement of these regulations will no doubt be necessary in the future.

Recent reports from Jackson County report that some enemy of the scale is destroying it in that section, and orchardists are encouraged with a hope that this pest my be held in check. The most successful method of combating insects is by the introduction of efficient enemies, and much good work might be done in this way if funds were provided for this purpose. The attention of the State Entomologist, Prof. A. Cordley, has been called to this condition of destruction going on in Jackson County amongst the scale, in the hope that if the enemy is discovered, it may be introduced into other portions of the state where the scale is doing its deadly work.

### CONDEMNATION OF FRUIT.

Scale, scab and codling moth have become so common in most parts of the state that clean fruit can no longer be grown without proper spraying. During the past year fruit was so scarce that a thorough execution of the law regarding selling diseased fruit for home use would have prevented many people from getting any fruit for family use; and for that reason the law was not strictly enforced, excepting with scaly fruit. It is the intention of the board during the coming year to enforce the law in every respect regarding wormy and diseased fruit, and growers bringing this kind of product to the markets will find it condemned and destroyed.

In this connection I wish to report that good success in keeping the codling moth in check has been achieved in many large commercial orchards, where not to exceed five per cent. of the fruit has been damaged. It has been accomplished, however, by the closest attention as to time, method and

thoroughness of spraying, usually five sprayings being required. Success in this work is only to be secured by the most minute thoroughness in the application of the spray, and a certainty of the purity of the material used. Hundreds of failures in spraying are reported to the board, but, in every case examined, the cause was found either in impure materials, not a sufficient number of applications, or general carelessness in methods of application.

Inasmuch as diseased and wormy fruit will not be allowed sold, even in local markets, it is quite important that growers should understand this, and be governed accordingly; the board has therefore constantly notified the public, through the press, of its intention to strictly enforce every feature of the law regarding the selling of fruit. It is very gratifying to learn, from the reports of the various commissioners and quarantine officer of the port, that the dealers in fruit are heartily in accord with the law which prohibits the sale of all infected, wormy, or diseased fruits, and will give every assistance in carrying out the provisions of this law.

And in this connection I would suggest that the fruitgrowers of this state urge upon the legislature the necessity for a small appropriation for the importation of beneficial insects, the value of which cannot be overestimated. Our neighboring state to the south has expended thousands of dollars in this line, with most beneficial results, and we could easily profit by this experience.

### ADULTERATED SPRAYING MATERIALS.

The board has earnestly endeavored to enforce the law regarding the sale of impure and adulterated materials for sprays. So far there has not been much good accomplished, because of carelessness on the part of the growers. Laws cannot be made effective to protect people who do not want protection, and until those who use this material feel the necessity for an execution of the law, the work of the board will not be successful in that direction. A great many of the disappointments in spraying come from adulterated materials. This is especially true of paris green and blue vitriol, and every orchardist should be sure that he is not being defrauded in these poisons.

The work of the board for the year has not been as effective as a whole as I had hoped. The individual work of the commissioners has been earnest and faithful, and the improved

condition of horticulture in the state is due to the generous work and real sacrifices of the members of the board. Each member is an enthusiastic fruitgrower, well qualified by knowledge and inclination for the position, and I am sure that no better work could be done by any other body of men with an equal amount of money at their command.

The work of the Secretary, Mr. Henry E. Dosch, has been painstaking, efficient and effective, and his generous services for the public in this position are deserving of the highest commendation.

The active interest in the work of the board by all persons connected with it indicates that valuable services are being performed. The vast amount of inquiry coming to all of the commissioners from all sections of the state; the renewed and continued interest in the board's activities from the fruitgrowers, give assurances of value in the law and general support in its execution.

The appointment of so earnest, capable and extensive a fruitgrower as Hon. E. L. Smith, as my successor, gives assurances of continued and more effectiveness of the work.

Respectfully submitted,

H. B. MILLER,
President.

# ANNUAL REPORT OF THE PRESIDENT.

*To the Honorable, the Governor, Secretary of State, and Treasurer of the State of Oregon—*

GENTLEMEN: Section 2 of the act of the legislature, approved February 17, 1899, amendatory of the horticultural law, provides that the President of the State Board of Horticulture "shall make an annual report to the appointing board of the general condition of the fruit interests of the state and success of the commissioners in exterminating pests and executing the law." In conformity with this requirement I have the honor to submit the following report:

My incumbency of the office of President of the State Board of Horticulture, dating from April 1, 1900, has been too brief

to give all the fruitgrowing portions of the state that thorough examination contemplated by the law. I have, however, traveled over three thousand miles since date of qualification, my visits extending from Malheur County on the eastern to Rogue River Valley near the southern boundary of the state.

It is gratifying to note that in every portion of the country that I have visited I have found fruitgrowers inspired with new confidence and the conviction that they can overcome the many adverse conditions that, in recent years, have threatened the fruit industry of the state.

At my suggestion the board authorized the publication of a spray calendar, giving the most approved formula for combating insect pests and fungus growths. An edition of five thousand copies was printed, but so great was the demand that it was soon exhausted. All the members of the board united in an earnest effort to induce the fruitgrowers to spray their orchards, with the result that in the more progressive districts the unsprayed orchard is the exception. Commissioner Schanno estimates that eighty per cent. of the orchardists of the fourth district are now provided with spraying outfits.

Experience has demonstrated that ninety per cent. of sound apples can be realized by the thorough application of modern methods. The evidence is accumulative as to this fact.

In the large orchards the hand pump must give way to the power sprayer, which does more thorough work with less than half the expense. Those up-to-date horticulturists, the Olwell Brothers, of Jackson County, make use of a small mounted gasoline engine, which drives the pump and agitator, and with which they are enabled to spray one thousand fourteen-year-old trees in a day. With this engine, two teams and four men, they perform the work that formerly required four spraying outfits and twelve men.

I am, however, inclined to the opinion that eventually we will discard the pump for compressed air, using a small stationary engine; compressor and tank carrying compressed air, and connected directly with the tank carrying the spray liquid. For further information on this subject see article in sixth biennial report, copied from the *Rural New Yorker*.

I have endeavored to keep in frequent communication with the commissioners of the five horticultural districts of the state, and commend their industry and fidelity in performing a large amount of labor with so small an allowance for time

and expense For detailed information as to the field work accomplished by these gentlemen you are respectfully referred to their accompaning reports, and from which I beg leave to note a brief summary.

The first district comprises the counties of Multnomah, Clackamas, Washington, Yamhill, Columbia, Clatsop and Tillamook. W. K. Newell, Commissioner. Mr. Newell, since his last report, has visited five hundred and twenty-five orchards comprising seven thousand three hundred and ninety-four acres. The value of the product of these orchards, including canned fruits, amounted, in the year 1900, to $439,940. The items forming this aggregate will be found in Commissioner Newell's report.

The second district comprises Marion, Lane, Polk, Linn, Benton and Lincoln counties. L. T. Reynolds, Commissioner. Mr. Reynolds has visited five hundred and twenty-six orchards and answered eight hundred and fifty letters. This district has about twenty thousand acres in fruit culture, largely in prunes. Value of crop for 1900, not including products of canneries, which was large, amounted to $134,642.50. Mr. Reynolds reports that growers have grown in strength and purpose during the year.

The third district embraces Jackson, Josephine, Douglas, Klamath, Coos and Curry counties. A. H. Carson, Commissioner. Since last report Mr. Carson has answered one hundred letters, mailed one hundred and twenty copies of fifth biennial report, and two hundred notices of disinfection, with copy of house bill No. 238, to growers whose orchards were infested with scale. He has visited, during this period, two hundred and six orchards. Value of fruit products of Jackson, Josephine and Douglas counties:

| | |
|---|---|
| Exported | $ 444,950 |
| Sold in district | 50,000 |
| Total | $ 494,950 |

Orchards constantly improving.

The fourth district embraces Wasco, Sherman, Gilliam, Morrow, Wheeler and Crook counties. Emile Schanno, Commissioner. Data at hand insufficient to form estimate of value of crop, which was large. Spraying becoming general in principal fruit sections.

The fifth district comprises the counties of Union, Umatilla, Grant, Baker, Wallowa and Malheur, nearly half the area of

the state. Judd Geer, Commissioner. Mr. Geer has answered, since last report, two hundred and twenty-seven letters, and visited four hundred and seventy-eight orchards, with an area of two thousand four hundred and seventy-six acres. Fruit industry in this district rapidly increasing, and orchards from six to ten years old yielding a carload to the acre. Two counties in this district, Umatilla and Union, produced, the year 1900, the following:

| | |
|---|---|
| Apples | 305 carloads |
| Green prunes | 45 carloads |
| Peaches | 4 carloads |
| Pears | 17 carloads |
| Strawberries | 11 carloads |
| Evaporated prunes | 40 carloads |
| Cherries | 5 carloads |
| Blackberries | 6 carloads |

Value of products not estimated, from the fact that a considerable portion of the crop is unsold. Baker and Malheur counties, in this district, were also exporters of fruit to a considerable extent. About thirteen thousand acres in fruit in the fifth district.

The foregoing summary will give some idea of the extent of the fruitgrowing industry in our state. The commissioners were requested to report the amount of lands in their respective districts adapted to fruitgrowing, and their approximations, so far as they have come to hand, are as follows:

Second district, adapted to fruit culture, four hundred and thirty-five thousand acres; now in fruit, twenty thousand acres.

Third district, one-fifth of land adapted to fruit now devoted to that purpose.

Fourth district, large areas along Columbia River suitable for grapes and peaches, one-fifth now in fruit.

Fifth district, four hundred and fifty-six thousand acres in cultivation, twenty per cent. adapted to horticultural pursuits, only three per cent. now in orchards. Large amount of land not in cultivation also suitable for fruitgrowing.

After giving the subject much study and examination, I am of the opinion that only about five per cent. of land suitable for fruitgrowing is now in use for that purpose, and that possibly no state has a greater area adapted to horticultural pursuits than Oregon. No small amount of money and energy has been lost from planting trees on lands unsuited for the purpose, probably five per cent. of the total acreage. Orchardists have been slow to learn that only deep, well-

drained soil, rich in the elements that enter into the growth of trees, is adapted to their purpose. Other common errors are too close planting and too many varieties. I recommend that standard apples be set not less than thirty feet apart and not more than four or five varieties for the largest orchard. Our nurserymen are partly responsible for the numerous varieties in our orchards in sending out trees not true to name. In my own orchards I have some twelve varieties that were never ordered, and my neighbors have suffered equally with myself.

While there are many conscientious men in the nursery business, but few raise all the trees they sell, and some are careless in methods of propagation. Greater care should also be exercised in cutting scions only from healthy, vigorous, fruitful trees, to be grafted on only thrifty, healthy seedlings. A law defining the liabilities of nurserymen who sell trees that prove not true to name would have a salutary effect and greater care would be exercised.

It is unfortunate that our commissioners are unable to inspect only the leading fruitgrowing sections of their districts. Each of our horticultural districts is as large as several eastern states, and it is impossible for a commissioner, with an allowance of but $450 per annum for time and travelling expenses, to cover such an immense territory. To remedy this the board had in contemplation the policy of recommending a change in the law to the effect that the county court of each county should appoint a fruit inspector, in line with our system of stock inspector, but, on more mature consideration, this plan is not deemed advisable. Some county courts might not be willing to make a reasonable appropriation for this purpose. It would be expensive to call such a large number together for council, and what is more important, it would be difficult, in many instances, to find men well qualified for the work. For the present, therefore, it seems the wisest plan to create two new districts, one on the east and one on the west side of the Cascade Range. I therefore respectfully recommend that the state be divided into seven horticultural districts, as follows:

First—Clatsop, Columbia, Tillamook, Washington, Multnomah and Yamhill.

Second—Marion, Polk, Lincoln, Benton, and Clackamas.

Third—Lane, Douglas, Coos, and Linn.

Fourth—Curry, Josephine, Jackson, Klamath, and Lake.

Fifth—Wasco, Crook, Sherman, and Wheeler.

Sixth—Gilliam, Morrow, Umatilla, Grant, and Harney.
Seventh—Union, Wallowa, Baker, and Malheur.

### ENFORCEMENT OF THE LAW.

The Horticultural Board has endeavored to secure compliance with the law without resort to drastic measures, and has succeeded so far as spraying and disinfecting of trees are concerned. More or less infested fruit still finds its way to our markets, but the quantity is small compared with former years.

It has been held that the commissioners have no authority to pay deputy inspectors, and it is utterly impossible for any one man to inspect all the fruit sent out of his district. The commission merchants, in many instances, have reported to our secretary violations of our quarantine laws.

It is not just to the grower who raises sound fruit to demoralize the markets by flooding them with trash that cannot pass inspection. We have endeavored to create a public sentiment in favor of the enforcement of wholesome regulations for the better protection of our orchards and markets.

### MARKETS.

Fruit production, not only in the United States but in Europe, in the year 1900 was the greatest ever known, and fears were entertained that the markets would be utterly demoralized. This, however, has not been the result in Oregon. The superiority of our Italian prunes and apples attracted many buyers, and remunerative prices have been realized.

There is a great incentive to fruitgrowing in Oregon, on account of rapidly expanding markets. Our facilities for distribution are unequaled. We are in reaching distance of several trunk lines of railway, which give us connection with all important transportation lines on this continent. They carry our fruits to New Orleans, to the Atlantic seaboard for exportation to Liverpool; to Manitoba and all the intermediate country. Our steamships, also, take large quantities of our horticultural products to Alaska and to our insular possessions. Slowly but surely we will invade the markets of Eastern Asia, and already inquiries come from Japan for quotations for a thousand-barrel lot of apples. That immense country, Siberia, the northern portion the counterpart of Alaska, is being rapidly developed, and I am confident, in time, will be a great market for Oregon-grown fruits.

Pajaro (Pathro) Valley is California's greatest apple section

and claims to raise one per cent. of all the apples grown in the United States. The value of the orchards of this valley run up to millions of dollars, and mansions costing thousands of dollars are found on these apple farms. The value of orchard lands exceeds those devoted to any other industry in the state, yet Los Angeles buyers came, in October, past the Pajaro Valley, one thousand two hundred miles north, to Oregon to buy their fancy fruit.

Lands in Nova Scotia, that were purchased six years ago, then in trees and stumps, for $10 per acre, cleared and planted to orchards, are valued at $500 per acre.

There is no other way apparent to me whereby we can enhance the value of the fruitlands of our state so greatly as to plant them in orchards.

There are only one thousand four hundred to one thousand five hundred acres in fruit in Hood River Valley. No large commercial orchards, yet her growers will realize $125,000 for the fruit crop of the year 1900. This industry is rapidly expanding, and the time may not be remote when the orchards and berry plantations of this little mountain valley may have increased tenfold, with a revenue in a favorable season amounting to $1,000,000.

From fifteen acres of Newtown Pippins, in Jackson County, I understand were gathered seven thousand boxes of apples, that no country could excel, and sold at Medford for $7000 for foreign export.

The timbered slopes of our noble Willamette Valley, up to an elevation of two thousand feet, are far more inviting to the orchardist than the flat lands below. And orchards will creep up these slopes and up the slopes of the Blue Mountains. And the grape and the peach will occupy every available position bordering on the Columbia in Oregon. Great orchards are being planted below the irrigating ditches in Malheur, and even the high plateau of Southeastern Oregon produces to perfection the hardier fruits.

Nature invites the horticulturist to Oregon. Soil, climate, and commanding position as to the markets of the world invite him. And the pursuit itself, the most beautiful of all related to the soil—every stage of growth, of bud, flower, and fruit, a miracle—invites him.

Respectfully submitted,

E. L. SMITH,
President.

Hood River, Oregon, December 1, 1900.

# REPORT OF THE COMMISSIONER.

## FIRST DISTRICT.

"Nothing is truer in the experience of life than that selfishness overreaches itself. He that would get the most out of life must contribute of his thoughts, sympathy, time and substance, for the good of others."—*Lucien C. Warner.*

HILLSDALE, Oregon, April 10, 1899.

*To the President and Members of the State Board of Horticulture, Greeting:*

Kindly permit me to hand you herewith my first quarterly report for the current year.

Since my return from Omaha last November, where I spent the summer as commissioner and general superintendent of the Oregon exhibits, the results of which are just beginning to materialize by the arrival of many immigrants, inquiries for lands of various kinds and the investment of capital in different branches of industry, I have attended the fruit-growers' convention, held at Corvallis in January, and delivered the closing lecture to the students of the farmers' short course at the Agricultural College, which was the largest class —nearly one hundred—that ever attended these studies since the course was inaugurated,—students from twenty-four counties being present,—showing that this course is gaining in popularity, the students being of both sexes and many advanced in years. I have been busily engaged in the inspection of the nurseries located in my district, and in examination of the fruit and tree shipments arriving at the Port of Portland. While on this point allow me to state that these shipments during fall, winter and spring are of almost daily occurrence, and in the absence of a quarantine guardian, or money to provide one, the duty of inspection falls upon the commissioner, requiring much time and expense. As it is deemed best to remove the office of the board to the City of Portland, for many good reasons, allow me to suggest that the secretary be made quarantine guardian of that port, thus avoiding any unnecessary delay in the delivery or forwarding of fruits and trees, as I am frequently away on field work, and these shipments have either to await my return or be delivered without inspection; and further, it would save many a dollar to be devoted for orchard inspection, where it would be of much more benefit.

### HORTICULTURAL TEXTBOOK.

According to custom, and agreeable with your instructions, I have compiled, edited, and read the proofs of our fifth biennial report, now ready for distribution. In the absence of any horticultural literature specially adapted to our various soils and climatic conditions, I concluded to make this report a "horticultural textbook," so to speak, so that any novice, or one already engaged in fruitgrowing, could find all he wished to know about any particular fruit, soils best adapted for their production, and sections most favorable to successful results; also insects and fungous diseases, and how to combat them, as well as a comprehensive spray calendar, as to how to spray, when to spray, why to spray, and what to spray for, so that there is no good reason for any one interested in horticulture to make mistakes. For this purpose I have, for the past two years, gathered material; hence the articles in the appendix, which are from the pens of our most advanced and successful fruitgrowers, and, based upon practical experiences—not theories merely—are most valuable, and implicit reliance can be placed in them. I spent over nine weeks with the State Printer, editing, compiling, and proofreading every galley. I feel that I have carried out your ideas faithfully, and, judging from the many flattering editorial notices, satisfactorily.

### NEW LAW BENEFICIAL.

What spare time I had at my disposal I spent in orchard inspection, and am gratified to state that much pruning and spraying has been done, and the click of the spray pump is heard in all directions. The new law, known as the "Morton Law," which makes it a misdemeanor to disregard notification to spray, had a most beneficial effect in my district, notably among smaller growers and home places near Portland, which were difficult to reach heretofore. I know of places, the owners of which had positively refused heretofore to do anything, which have been pruned and sprayed since the passage of that law, the owners not waiting to be notified to do so. Yet some aggressive work is now necessary, especially against old dilapidated apple orchards which are still to be found in many sections. These will either have to be thoroughly pruned and sprayed, or, better still, dug up bodily and burned, as most varieties are worthless and unmarketable at best. With this point in view I have thus far notified twenty-nine owners of orchards to prune and spray within thirty days under the law.

### NECESSITY FOR TELLING THE TRUTH.

Shortly after the cold wave which passed through the center of the Willamette Valley early in February, I was invited, while at Salem, to examine the orchards in that vicinity, and reported that I found all prune orchards planted on low, wet, heavy clay bottom lands badly injured, and predicted that these trees would die, while orchards located on hill land, and planted in proper soil, were in perfect condition, and from appearances would yield a fair crop. I was somewhat criticised for this, as many persons, some living one hundred miles from there, took it for granted that my remarks applied to the whole state, though I never could understand just why. I also received several sharp letters from prune land sellers, stating that I had no right to express my opinions as such were calculated to ruin the prune industry. Right here permit me to say that the planting of orchards on lands not adapted to fruit culture, and selling them at fancy prices to newcomers, has done more injury to the fruit interests of Oregon than any other one thing, and it is high time to warn intending buyers that all lands, even in this favored region, are not suited to fruit raising, nor the enormous results figured out on paper likely to be realized. I hold that it is the duty of this board to give the actual facts, the truth, which is right, and right wrongs no man. We have many favored localities adapted to fruitgrowing, but heavy, clay, wet soils, or lands from which the water will not drain, is not fruit land. Permit me to add that upon recent examination of the trees that I said two months ago would die, many were found to be dead even now, thus verifying my prediction.

### NEW MARKET IN THE ORIENT.

In my last report I spoke about marketing our fruit, which is the great problem confronting the fruitgrowers at this time, and called attention to the new market opening to us, giving statistics and other data in connection therewith, especially the market of England; but more particularly the Orient. I have made considerable inquiry since then into this Oriental market, which, it seems to me, belongs to us of the Pacific Northwest, and from information gathered, am more than ever convinced that this is the field for us to operate in. The difficulty which seems to lie in the way is the long ocean transportation, and whether our fresh fruit will stand this

long voyage on board steamers. I have learned that a number of boxes of apples, well selected and carefully wrapped, were sent to Manila, and arrived there in most excellent condition. There is no doubt in my mind that China, Japan, the Philippine Islands and Siberia, will consume all our fresh apples and evaporated prunes and pears, if properly introduced in those markets. Our fruitgrowers should combine and send someone to the Orient for this purpose—a man of business training—one who enjoys the confidence and commands the respect of his community. The business of these countries are in the hands of the German, English, and Americans, I am told, and therefore it requires some one who can come in close touch with these business people, and who will inspire that confidence and possess that business integrity which allows no failure. The field is of such importance that it should be taken in hand at once, and so vast that the end can not now be seen.

### OUR FRIEND THE BEETLE.

Before closing, I beg to report that our little friend (*pentillia mesilla*) the coccenella beetle, which I first reported upon some years ago, has increased and spread over a larger territory than I anticipated, and has been feeding on San Jose scale and oyster shell bark louse all winter, and am more than gratified to find that it has extended its field of operation. On examination of the woods adjacent to the infested orchards, where scale has fastened on crabapple, hawthorne and other shrubs, I find these same beetles industriously busy in their work exterminating these various scales, so if the orchardist will keep his orchard well sprayed, I feel confident that these little friends of the fruitgrower will do the rest.

Respectfully submitted,

Henry E. Dosch

Commissioner First District

# REPORT OF THE COMMISSIONER.

## FIRST DISTRICT.

### FIRST SEMI-ANNUAL REPORT.

DILLEY, Oregon, Oct. 9, 1899.

*To the President and Members of the State Board of Horticulture:*

Herewith I present my first semi-annual report. My appointment, in April last, to succeed Mr. Henry E. Dosch as commissioner for the first district, was very much in the nature of a surprise to me. The work being all new to me, I have endeavored, during the present season, to obtain a general idea of the conditions over the most important parts of my district, leaving it to be worked more thoroughly later. Therefore I have visited mainly the larger orchards and interviewed the most prominent growers.

In Yamhill County I have visited McMinnville, Carlton, North Yamhill, Lafayette, Newberg, Dundee, and Dayton, stopping at all the principal orchards, dryers, and packing houses: in Washington County the Dilley, Gaston, Forest Grove, Cornelius, Hillsboro, and Cedar Mills districts; in Columbia County, between Scappoose and St. Helens; in Clatsop County, the Youngs River, and Lewis and Clark River Districts, and the Clatsop Plains; in Clackamas County the Milwaukie, Oregon City, Springwater, New Era, and Canby districts; in Multnomah County, the Columbia Slough, Sandy, Base Line, Section Line, and Powell Valley roads, each to a point about ten miles distant from Portland. Tillamook County I have not visited at all.

In parts of my district I find many orchards badly infested with the San Jose scale, especially between Oregon City and the Columbia River. In this region it is so prevalent that it was useless to attempt to fight it with summer sprays, but I propose to wage vigorous war on this dangerous pest during the winter months. In one orchard, two miles south of Oregon City, I found a few scale on young apple trees, undoubtedly brought there on nursery stock, and at Newberg one pear orchard was found slightly infested with it. With these two exceptions, which were ordered cleaned up, I have failed to

find any San Jose scale south of Oregon City or west of the Willamette River, so that by vigorous measures it may be stamped out before it spreads all over the district. They appear to attack prune and pear trees, and currant bushes, in preference to anything else.

All kinds of aphis seem to have been especially active this year. The black aphis attacked the cherry trees in May and June in such numbers that it was feared for a time that the trees would be ruined. In many places they were nearly denuded of their leaves, and even the fruit was covered with the disgusting pest. Happily they disappeared with the coming of settled warm weather, and I believe that with an ordinarily favorable season they will not do much damage. They are difficult to fight, on account of their causing the leaf to curl up around them, thus preventing the spray from reaching them. Should they appear again next spring, I would recommend a strong spray of quassia chips and whale-oil soap, applied at the very first appearance. In the only orchard and nursery that I found where this pest was successfully combated this spray was used.

The apple canker is everywhere, and is undoubtedly the most serious disease confronting the Western Oregon orchardist today. It is causing the utter ruin of many young orchards, while but few growers seem to recognize the necessity of fighting it. The knife, followed by frequent and thorough washings and sprayings, is the remedy. Badly diseased trees should be dug out and burned at once; while others may have the spots cut out and sprayed with bordeaux mixture. As the spores ripen up, and are spread by the wind in the fall, a strong spray applied immediately after the leaves fall will be most efficacious.

Many prune trees were killed by the last winter's freeze, though the damage was not so great as was at first feared. Two classes of orchards seem to have suffered the worst, the neglected ones, and the overcultivated ones. The latter, especially where planted on undrained soil, or with a southern exposure, were almost ruined. Taking the district over, probably fifteen per cent. of the prune trees have been destroyed by the freeze. As is well known the prune tree has always suffered more or less from freezing of the trunk, in this climate, and I believe that the so-called prune canker is nothing more nor less than frozen trunk. I can see no remedy but to wrap the trunk of every tree when planted, and keep

it wrapped until the tree is seven or eight years old, when, if properly grown and healthful otherwise, it should be able to withstand the elements.

The almost complete failure of this year's fruit crop is very discouraging, and many small growers are grubbing up or neglecting their orchards, but those men who have gone into fruitgrowing as a business are mainly taking good care of their trees and still looking hopefully forward to next year.

I was requested to visit the country around Astoria with a view to seeing what might be done to encourage the fruit industry there. It seems to me, and I so reported, that apples and all kinds of small fruits could be grown very successfully along the foothills, a few miles from the coast. I certainly never saw finer raspberries and blackberries than are grown in a few gardens on Bear Creek and Youngs River. What few apple trees are planted are very healthy, and, probably owing to the fog and salt air, the fruit is not troubled by the codling moth.

In regard to enforcing the law concerning the sale of wormy and diseased fruit, I have had the sections of the law applying directly to this published in one or two papers in each county, and have personally delivered or mailed a copy to every dealer in the towns outside of Portland, and have condemned several lots of fruit.

WILBUR K. NEWELL,
Commissioner First District.

## SECOND SEMI-ANNUAL REPORT.

DILLEY, Oregon, April 9, 1900.

*To the President and Members of the State Board of Horticulture—*

GENTLEMEN: I herewith submit my report for the term ending April 9, 1900:

During the past six months I have carefully inspected all the nurseries in my district and visited several hundred orchards. With two or three exceptions I have found the nurseries in excellent shape, and I think I may truthfully say that nothing but sound, healthy stock has been sent out to purchasers. Notices have been served on over three hundred owners of fruit trees to either destroy their trees or prune and spray them; these were mainly for trees infested with San Jose scale. In every instance the notice has been complied with, but frequently, I fear, in a manner that has

done little good. I see no remedy for that, under our present system, but to wait until a reasonable time proves that no good has been accomplished, then require them to do it over again.

In localities where fruitgrowing is a prominent industry public sentiment is strongly in favor of thorough pruning and spraying, of clean trees and clean fruit. But in many other places it is almost impossible to secure effective work.

In my last report I stated that San Jose scale had been found in an orchard at Newberg; this has been stamped out by removing the infested trees and thoroughly spraying the remainder of the orchard. I also found scale in an orchard at Hillsboro; here the same plan was adopted.

For some months past I have been noticing the large number of prune trees that have died without any apparent satisfactory reason therefor. The cause has generally been attributed to sour sap caused by the severe freezing in winter. But this seems to me hardly adequate; I fear there is some disease among our trees. Of course a great number of trees have died from freezing, but many others are lost apparently from other and unknown causes. One of the well-known and best-informed orchardists of Oregon advances the idea that the cause is a disease somewhat similar to the dreaded peach-yellow—a disease of the circulation or sap. I am inclined to agree with this, and think it should be investigated by some competent scientist. The remedy would be to at once remove and burn all dying trees the same as is done with peach-yellow. Pending investigation, the remedy should be applied anyway to prevent needless risk.

The prospect is now most excellent for an enormous crop of fruit of all kinds. Should there be a full apple crop all over the United States a wormy apple will be unsalable at any price. Therefore, apple-growers should plan to wage vigorous warfare against the codling moth. There is great diversity of opinion as to where the first spray should be applied; some authorities saying that the early spray, just after blossoms fall, is the only one of much use; others that the later sprayings are the effective ones. I think it safer to compromise and do both. While the moth seldom appears before June 20 in the Willamette Valley, I think the first spraying should be done much earlier, as by that time the calyx end of the apple is closed so that no spray can enter. Applied earlier it can not wash out and is there awaiting the

worm when he does come. Of equal importance with spraying is the destruction of the full-grown worm to prevent the breeding of more moths. Pigs or sheep should be kept in the orchard to eat every apple as soon as it falls. The plan of banding the trees is also of great benefit. This is largely practiced in Idaho and has proved a very important help. A piece of burlap is tied around the tree below the limbs, and as the worm crawls along hunting a place to hide away and spin his cocoon, he finds this and immediately crawls under. The bands can then be removed and the worms destroyed. As it takes only a few days for the moth to emerge, the bands must be examined every week or they will prove only a protection to the worm. Houses in which apples are stored during the winter should be screened to prevent the moths emerging in the spring. With these precautions carried out all along the line, the codling moth would soon cease to be a terror and Oregon once more become famous as the land of big red apples.

WILBUR K. NEWELL,
Commissioner First District.

# FINAL REPORT.

## FIRST DISTRICT.

*To the President and Members of the State Board of Horticulture:*

Herewith I submit my first biennial report. I have served as a member of the board for a year and a half, my commission bearing date of April 22, 1899, and this report will cover my work during that time, together with such suggestions as may have occurred to me. I was appointed to fill out the unexpired term of Mr. Henry E. Dosch, who resigned as commissioner, to become the secretary of the board.

My district comprises Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop, and Tillamook counties, a section entirely too large to be covered in the time, or with the means,] at my disposal. I have endeavored to put my time to the best advantage, giving the nurseries my first and most careful attention, bestowing the remainder of the work on the most important fruit sections. Tillamook County, I

must confess, I have not visited at all, and Columbia and Clatsop only a very few localities. The other counties have been fairly well covered, that is, in the main orchard districts.

A large number of letters have been received, asking information of various kinds, all of which have been answered to the best of my ability. So many inquiries in regard to spraying were constantly being received by all the members of the board that, in April, President Smith suggested the issuing of a special spray calendar. Secretary Dosch undertook the task and published a small bulletin, giving complete, up-to-date formulas for making, and full directions for applying, all the best remedies. This filled a long-felt want and met with a hearty reception, the edition of five thousand copies being soon exhausted. During the past eighteen months I have visited five hundred and twenty-five orchards, containing seventy-three hundred and ninety-four acres, divided as follows: Twenty-two hundred and thirty-four acres of apples, thirty-eight hundred and eighty-eight prunes, and twelve hundred and seventy-two miscellaneous—comprising pears, cherries, peaches, nuts, etc. The principal fruit of the district is, of course, the Italian prune. This variety comprises four-fifths of the prune acreage and brings in more money than any other single fruit. Other varieties of prunes are the Petite (which this year has been so unprofitable on account of its small size), the Silver (a fine fruit, but not profitable because the tree is so tender and short lived), and the Willamette—a promising prune of the Italian type, whose merits are just now beginning to be recognized. Small fruits and berries, grown for the local markets, bring in a large sum of money—much greater than is generally recognized.

Nut culture is slowly but surely coming to the front as a branch of horticulture. It has been proven that such varieties of soft-shelled walnuts as Mayette, Franquette, and Parisienne, Languedoc almonds, and many varieties of chestnuts, can be successfully and profitably grown in Western Oregon. Two large plantings of walnuts have been made, one of seventy acres by Mr. Thos. Prince, of Dundee; and one of twenty acres by Mr. Chas. E. Ladd, at Oak Hill Farm, near North Yamhill. One man near Portland sold over $50 worth of chestnuts this year from a few trees along the driveway from his gate.

The saddest thing observed is the state of the apple industry in Western Oregon. The Willamette Valley, once so famous for its magnificent apples, is now scarcely recognized by the

commercial world as an apple producer. The development of the fruit industry in California largely cut off the profitable market, the building of railroads brought in all the pests from the outside world, prices became low, and fruit diseased, and the apple was cast aside for the prune. This should not be, for while I think the prune will lead in value, I see no reason why the apple should not regain its old-time prominence. But first the old, neglected, diseased apple orchards must go. They have served their time, and must now be replaced by young, vigorous stock of improved varieties, on new soil, and with the latest and best methods of culture. I have succeeded in accomplishing something in the way of removal of these old trees, but vastly more remains yet to be done. Near Portland great difficulty is experienced in finding owners of tracts of land containing old trees, where former orchard lands have been platted and sold in small tracts. The law requires that the owners shall be notified, and where they cannot be found we are helpless. This should be changed, allowing the commissioner to have diseased trees removed, after due search for the owner, or due notice posted on the property.

The general condition of commercial orchards is steadily improving. The crop of 1898 was a remunerative one, and stimulated growers to renewed efforts, so that the disastrous season of 1899 did not cause discouragement.

Marked progress has been made in the last two years in the matter of spraying for codling moth and San Jose scale. Careful growers are now able to obtain ninety-five per cent. of apples free from worms. The use of the new arsenite of lime spray has been a great help. San Jose scale in my district is confined chiefly to Multnomah County and Clackamas County, from Milwaukie to Oregon City. I have found them, however, in Hillsboro and Newberg, in small quantities, and in both instances took immediate steps to destroy them, and think their further spread in these districts can be prevented. One good heavy winter spray of lime, sulphur, and salt applied each year will hold the scale in check so that it need not be feared. Its total extinction can hardly be hoped for, and if it is accomplished it must be through the aid of nature. California has spent large sums in importing insects and birds to prey on the scale, and Oregon might well profit by her example. The scale here seems to prefer mountain ash and currants to any other trees or shrubs, but they also attack the

prune, peach, pear, plum, apple, cherry, except the sour varieties, apricot, nectarine, almond, and quince. Any person owning any tree of these varieties should inspect them carefully, at least once a year, for this pest.

During the last winter I sent out, or personally served, over four hundred notices to spray for scale, anthracnose of the apple, and pear blight; principally for the former. Lack of time and funds prevented my following up all the cases in time, but the great majority complied with the instructions in a reasonably thorough manner.

The board's educational work, through the wide dissemination of the fifth biennial report and the spray bulletin, and the correspondence and personal visits of the members, has been of great value. In the great majority of cases we are met by a gratifying desire for information and an eager interest in our work.

I have attempted, insofar as possible, to obtain an accurate estimate of the fruit output for the past year, but it is a difficult undertaking; as is well known, even the census bureau, with all the facilities at its command, can scarcely obtain reliable figures; hence, aside from the prune figures which I have received direct from the evaporators, the estimate can not be taken as authoritative. The output of dried prunes for my district for this season was approximately two million two hundred thousand and ninety-eight pounds, valued at three cents per pound, or $68,940; of merchantable apples, sixty thousand boxes at sixty cents per box, or $36,000. The canneries, vinegar factories and cider mills have put up a product valued at $135,000; and the value of small fruits and berries, and other fruits not estimated, will foot up fully $200,000. This latter estimate is an average of several submitted by leading dealers and growers. Thus the total value of the fruit product for my district approximates $439,930.

While this is a fairly good showing for the season, it is nothing like it should be. Simple neglect of spraying has caused the loss of fully fifty per cent. of the apple crop. Good apples are worth from forty cents to $1.00 per box, but thousands of boxes have been fed to the hogs or sold to the cider mills simply because they were wormy, and, hence, not allowed to be sold in the market. A few hundred dollars spent in spraying throughout my district would return several thousand just in apples saved.

The action of the board in preventing the sale of wormy

apples this season has done more to open the eyes of fruit-growers to the necessity of spraying than any other line of action that could have been taken. It is manifestly impossible to compel every grower to spray for codling moth, but when you prevent his selling his wormy fruit in the market you at once touch his most vulnerable point—his pocketbook.

The most common way of spreading diseases of trees and insect pests is by the shipping of nursery stock. To this point I have given my most careful attention and am sure that nothing but good clean stock is now being sent out. The nurserymen of my district have one and all seconded my efforts cheerfully and heartily, inviting the most careful and thorough investigation, and whenever anything wrong was found, at once remedying the matter.

Nursery stock is now shipped from the Willamette Valley all over the Northwest, Washington, Montana, Idaho, and even British Columbia looking to this section for their best trees. This part of the business should expand to great proportions, and it will if care is taken to maintain the present standard of trees shipped. It is universally conceded that no better trees can be grown than are produced here. California has always been a heavy buyer of prune and cherry trees from Oregon.

It is encouraging to note that prices of nursery stock are now getting up to a good paying basis. The prices of three and four years ago, when prune and apple trees wholesaled at two and three cents, were ruinous. A great deal of poor stock was sold at that time simply because good stock could not be produced at such figures. The present wholesale prices of seven to ten and twelve cents is a fair and just one to both producer and consumer. The best of trees can be produced at a profit at these prices, and it is no hardship to the planter to pay them; in fact I should say it was a benefit to him, for it will, if he wishes economize, cause him to plant fewer trees to the acre, and also cause him to be more particular as to what he plants and how he plants it.

There is one point to which I think nurserymen should give more careful attention, and that is to the selection of their buds and scions for grafting and budding. Too frequently these are taken from the nursery row, which, of course, can not be well ripened and matured wood; the tendency of such selection being to induce wood growth in the young tree at the expense of fruit growth. Buds and

scions should always be taken from bearing trees, and not only that, but taken from the very best type of bearing tree of the variety desired that can be found. As everyone knows, there are always certain trees in an orchard that bear more regular and bear finer fruit than the others. These are the trees that should be chosen to propagate from. Thus the trees can be brought into bearing much earlier and the quality of the fruit steadily improved. Careful experiments have demonstrated that trees budded from trees that in their turn were properly budded, came into bearing two or three years earlier than ones just budded from stock in the nursery row; in fact the latter sometimes never come into profitable bearing. Trees can be improved by careful breeding just as readily and easily as breeds of stock, and the necessity for doing it is just as great. Our present standard varieties can and should be bred up until they are all a fruitman could ask. Here is work for the nurseryman that will pay better than endless chasing after new varieties, ninety-nine out of every one hundred of which are a delusion and a snare, a fact which every orchardist knows from experience. The importance of this subject is not half realized. Think what it would mean if every tree that is planted would come into bearing at three or four years of age, instead of six or eight as commonly now. Every purchaser of trees should make this one of the first points in his selection of trees, buy only from a nurseryman that you know uses this care in the selection of his breeding stock. Such stock will no doubt command a higher price, but that is a small matter, for the original cost of the tree is only a small item in the cost of growing an orchard.

Throughout my district probably twenty-five per cent. of the land that is capable of tillage at all is pre-eminently adapted to fruit culture; yet one finds a great many orchards in soil that is totally unfit. As a general rule, soil that is, or has been, occupied by the fir or oak trees, or hazel bushes, is suitable for fruit trees; but, almost without exception, every acre of such land should be underdrained to secure the best results, no matter whether it is on the highest hill or in the deepest valley. Most of the land of Western Oregon has a clay subsoil, and all such land needs tiling. Fruit trees will never thrive with wet feet. The only land naturally thoroughly drained is a gravelly soil, or one where the subsoil of gravel comes within two or three feet of the surface. So that

the soil is of the proper kind as to richness, texture and drainage, it matters little whether your orchard is in the valley or on the hill, provided that in the valley you are not in an unduly frosty locality, or on the hill in too windy or exposed a location. As regards the prune, the hill orchards are rather more sure of a crop — they suffer less injury from spring frosts; but the valley orchards, when not injured in the spring, produce the heaviest crops and the largest sizes of fruit. The northern slopes of the hills are undoubtedly the best for prunes and cherries, as their fault is early blooming, and being on the north tends to hold them back a little in the spring, and also, in case of a frost, they do not catch the early sun, have a chance to thaw out more gradually, and are thus often saved where blooms on the south or southestern slope are ruined. With apples and pears, they being later bloomers and more hardy, I can not see that it makes any difference.

Grapes should always be on a southern or southwestern slope, with a valley or at least a ravine below them where the cold air can settle at night. It is better also not to plant quite to the top of the hill. During the growing, and especially the ripening season, the grape in this climate needs all the heat it can possibly get, and the object is to so plant on the southwest slope that they will get the full strength of the afternoon sun.

The Puget Sound Country annually imports several carloads of New York or Ohio Concord grapes. Now Oregon can and does produce just as fine a Concord grape as New York or Ohio can possibly boast of, and there is no reason why we should not supply all that Puget Sound and British Columbia demand. There is even a demand for Concord grapes in San Francisco, and no doubt a good trade could be worked up for them there, as they do not thrive in California. There is an expanding market for all our fruits. China, Siberia, Alaska and the Philippines will take our prunes and apples in unlimited quantities once they are thoroughly introduced and trade relations established. Travelers tell us that the Russians in Manchuria and Siberia take very kindly to our prunes and will, in time, consume immense quantities of them.

There is another line of fruit culture that must be developed, and that is the growth of berries and small fruits for canning and preserving purposes. No country on the face of the earth can produce finer strawberries, blackberries, rasp-

berries or currants than the Willamette Valley, nor produce them any cheaper. Yet go into our stores and ask for jellies, jams, or preserves, and what do you find?—Cross & Blackwell's England, or Bishop & Co.'s Los Angeles. I am happy to say that owing to Food Commissioner Bailey's good work they are no longer principally from Sioux City or other corn sections. But they should bear Oregon brands, and be sold everywhere as such. Three years ago a man in Olympia, Washington, put up a few jars of strawberry preserves; they sold well, and he increased the next year; this year, I understand, he has put up one hundred thousand jars. Oregon should do the same.

The cannery business is growing rapidly now. This year several large plants have been in operation; they have paid remunerative prices to the grower for his fruit, and, I am told, have readily sold their pack at profitable prices. Several other canneries are proposed for next year, notably at Newberg, McMinnville, Dallas, and Corvallis.

To sum up, there is encouragement in almost every line of fruitgrowing; true there is lots of hard work, risk and worry in it, but at the same time excellent chances for good profit. It is an unlimited field for brainwork, a chance for all the skill and knowledge anyone can bring to bear upon it; and, withal, the most pleasant and healthful work in which man can engage.

In regard to the work of the board, I think the system should he changed to conform to that of California and Washington; that is, to have one commissioner-at-large for the state, and a secretary, and then let each county have an inspector of its own. With the present system and limited funds it is impossible for the commissioners to cover their districts effectively. I think it is an important point that the inspectors should be actually engaged in fruitgrowing as at present, but no fruitgrower worthy the name can, in justice to himself, spare the time to attempt to do the work at present required of the members of the board. But to cut the districts down to single counties would allow of effective work being done.

WILBUR K. NEWELL,
Commissioner First District.

# REPORT OF THE COMMISSIONER.

## SECOND DISTRICT.

### SECOND SEMI-ANNUAL REPORT.

SALEM, Oregon, April 9, 1900.

*To the President and Members of the State Board of Horticulture:*

Since our last annual meeting there has been a great change in the prospects of the fruitgrowers of the second district. At that time the greater number were discouraged and ready to abandon the business. Many, indeed, thought whole orchards were ruined, and a few went so far as to dig out their orchards without waiting to see what the outcome would be. Few had the courage to spray, plow and cultivate as if a crop were to be harvested. This condition was not without good reason in many cases. Some were confronted with mortgages and interest, without any means of meeting their obligations, and in not a few instances men were compelled to leave their orchards and seek outside employment in order to provide a living for themselves and families. Under such conditions, it was very hard to secure co-operation of the growers in an effort to care properly for their orchards. The clouds have rolled by, however, and the sky is clearing, in view of the fine prospects of a good crop this season.

With the anticipation of a good yield, growers are again becoming interested in the question of spraying, with the hope of saving their fruit and preserving the health and vigor of their trees. To this end information is constantly being sought in regard to the best methods of spraying, remedies, kind of apparatus, etc. Such inquiries have been answered with the best information we were able to secure on the subject. Numerous inquiries have been received relative to the best plan for building an evaporator. To such questions we reply by advising those who intend to build to examine the different styles of evaporators, and learn their respective merits through those who have used them.

Fruit trees were in demand this season, and, in consequence of the higher prices to be obtained, some nurserymen seem to have been a little careless in allowing poor stock to be sent

A commercial Italian Prune Orchard near Salem, Willamette Valley.

out at the beginning of the shipping season. Such shippers were immediately notified that the greatest care must be exercised as to kind of stock sent out, and that all nursery stock must be properly fumigated according to law. All recognized the importance of sending out nothing but clean nursery stock, and agreed to comply with all the requirements of the board, which I believe has been done.

Notices to spray have usually been effective in securing spraying, but much of the work in this line is not done so thoroughly as it should be. This will, in many instances, require that the trees be sprayed again in the fall. A few old orchards have been cut down as a result of notices having been served on the owners, and this is often more satisfactory to all parties interested than to attempt to renovate trees which have long since passed the age of usefulness.

More interest is being taken in the work of the board this season than for some time past, and a large number of letters have been received, during the past three weeks, requesting a visit this spring. These visits will be made as soon as the roads will permit.

One shipment of nursery stock sent from the east was found to be badly diseased, and was ordered destroyed. Two lots of apples infested with San Jose scale were also condemned and destroyed.

One thing which is very important, and which, I believe, the board should undertake to secure, is the importation of parasitic insects which prey upon scale. The little beetle, *Pentilia Missella*, is found in many places, but is by no means sufficient to furnish a check to the scale, and it would be of great benefit if other similiar insects were secured.

L. T. REYNOLDS,
Commissioner Second District.

# FINAL REPORT.

## SECOND DISTRICT.

SALEM, Oregon, December 1, 1900.

*To the Honorable State Board of Horticulture—*

GENTLEMEN: In presenting this report for the past two years it may be well to call attention to the district embraced in it. Six counties are included in the second district, nearly the whole territory being in the rich and productive Willamette Valley. They are Marion, Polk, Benton, Linn, Lane and Lincoln. In all of these counties fruitgrowing is becoming one of the leading branches of agriculture. The approximate acreage of the commercial orchards in the second district is given by counties, as follows: Marion County, five thousand three hundred and ninety acres; Linn County, one thousand four hundred acres; Polk County, one thousand five hundred acres; Lane County, one thousand nine hundred acres; Benton County, one thousand four hundred and fifty acres; Lincoln County, four hundred acres. This does not include the home orchards of an acre or more, nor the numerous old apple orchards.

When we say that there are twelve thousand and forty acres in fruit in this district, it conveys to the average reader very little idea of the magnitude of the industry, but when one undertakes to visit these orchards and finds that they are distributed throughout a district containing thirteen thousand six hundred square miles, or an area greater than the combined area of the states of Connecticut and Massachusetts, he realizes something of the growth of horticulture in the Willamette Valley, and at the same time appreciates the extent of territory embraced in the above-mentioned counties, as well as discovers their unlimited resources.

More than eight hundred and fifty letters have been received containing many requests for information, and these have been answered as fully as possible. We have visited five hundred and twenty-six orchards, which have ranged in size from four or five acres to two hundred acres. In addition to work done among orchards hundreds of city lots have been visited and trees on them examined, it being found that the greatest increase in the San Jose scale has been in the cities. The orchards visited have been distributed as to acreage in

Spraying in Fir Grove Fruit Farm Dr. J. Reynolds, Salem.

the different counties as follows: Lincoln, one hundred and twenty acres; Linn, six hundred and eighty acres; Polk, seven hundred and eighty-five acres; Lane, nine hundred and eighty-four acres; Benton, nine hundred and ninety-four acres; Marion, two thousand two hundred and seventy-five acres; the total being five thousand eight hundred and thirty-eight acres. Of the fruits grown in the second district the prune is far in the lead as regards acreage, occupying four-fifths of the whole orchard acreage of the district. Apples comprise one-tenth (not including old orchards), pears one-fifteenth, and cherries about one-thirtieth.

When one considers the area susceptible to fruit culture in this valley, it is seen that a very small part of the available land is devoted to orchards. There are over eight million seven hundred thousand acres in the district, of which it is estimated that five per cent. would be adapted to fruit culture, or about four hundred and thirty-five thousand acres. Allowing eight thousand acres for old orchards and home fruit gardens, not included in our summary of the fruit acreage of the district, would give us a total of twenty thousand acres now used for orchard purposes, leaving four hundred and fifteen thousand acres still available for fruit. This calculation assumes that the present orchards are on land adapted to fruits. As a matter of fact, however, nearly ten per cent. of the fruit trees have been planted on land entirely unsuitable for orchard purposes and will never be profitable. This, to some extent, accounts for the poor condition of many plantations. Planted on thin, poorly drained soil the trees make a desperate struggle for existence for a few years. Many succumb to the first severe frost, others are drowned in the wet soil, the orchard soon presents a ragged, sickly appearance and the owner concludes that fruits are unprofitable, when a little common sense would have shown him that his trees could not live on wet, white land.

While many orchards have been damaged by weather conditions which could not be controlled, yet progressive fruit-growers are everywhere getting their plantations into the best possible shape, realizing that it is only through carefully planned and thoroughly executed work that their orchards can be made profitable. Growers are purposing a more thorough campaign against the codling moth during the coming season than has ever been made in this valley, and increased interest is shown in methods of cultivation, pruning and fertilization. Orchardists have gained in the knowledge

of injurious insects and fungous diseases and are acquiring a knowledge of the best methods of controlling and reducing their ravages. It is evident that many are studying carefully the publications of the board and the bulletins of the Agricultural College, since questions are often asked concerning a proposed line of treatment, and occasional criticisms and suggestions are received. All this is encouraging, for it indicates a progressive, wide-awake disposition on the part of many growers, which is big with promise of future results. While spraying has by no means become general throughout the district, a large amount of spraying has been done, especially for the San Jose scale and apple tree anthracnose. Growers are thus learning the value of spraying and are coming to consider it one of the necessary operations in the successful orchard.

The work done in the district, in addition to visiting orchards and the usual correspondence, has included the inspection of both fruits and nursery stock, inspection of nurseries, and the inspection of a large number of trees on city lots. One shipment of trees was condemned, and all diseased trees destroyed, and three partial shipments of fruit were condemned. Shippers generally have shown a disposition to obey the law, and are usually careful to see that none but clean fruit is packed. Very few pears were shipped this season; the market having been unfavorable for eastern shipment. Only three cars of green Italian prunes were shipped. These were shipped from Eugene, by T. N. Segar, and were excellent samples of Oregon's favorite prune. During the past winter many trees were examined in city lots and found infested with the San Jose scale. Eugene was thoroughly canvassed in this way, and Albany and Salem partially, the time at command being insufficient to thoroughly examine all portions of the latter places. Notices to spray were served on all whose trees were found infested, and these were generally obeyed, though in some instances the work was not sufficiently thorough. It is a matter of regret that a part of this work was necessarily deferred until this winter. Articles were written for the press calling attention of property owners to the necessity of examining their trees and spraying them when found infested, and the proper formulas were given. These served a useful purpose, as many twigs and branches were brought that insects on them might be identified. The little beetle, *Pentilia Missella*, has been found in a number of places and is doing a good work in the destruction of scale insects.

My attention was recently called to a shipment of apple trees, the small fibrous roots of which were nearly all dead. As there was no evidence of disease it was thought they were possibly killed by too strong fumigation. Samples were sent to Prof. A. B. Cordley, and our suspicions were confirmed in part, as Professor Cordley replied that the tender roots might be killed by getting the gas too strong, or leaving the trees in the fumes too long. He advises that if nurserymen carefully follow the directions of the board they will have no trouble.

Owing to April frosts and unfavorable weather conditions during the blooming period, it was at first thought that a very light fruit crop would again be harvested in the Willamette Valley; but, while the crop was greatly reduced, there was, nevertheless, a fair average secured, except in case of the Italian prune, which was very light in many districts.

I present herewith the estimated production of dried prunes for each of the past three seasons:

YIELD OF DRIED PRUNES IN SECOND DISTRICT.

| *County.* | *1898.* | *1899.* | *1900.* |
|---|---|---|---|
| Marion | 2,975,000 | 72,000 | 1,820,000 |
| Polk | 825,000 | 48,000 | 560,000 |
| Lane | 860,000 | 30,000 | 600,000 |
| Linn | 395,000 | 10,000 | 220,000 |
| Benton | 875,000 | 20,000 | 225,000 |
| Lincoln | 20,000 | | |
| Totals—pounds | 5,950,000 | 180,000 | 3,425,000 |
| Value | $193,447.72 | $9,000 | $134,812.50 |

The production and value of the other fruit crops of the district is shown in the following table:

| *Fruit.* | *Yield.* | *Value.* |
|---|---|---|
| Blackberries—pounds | 150,000 | $ 4,500 00 |
| Cherries—pounds | 310,000 | 7,750 00 |
| Pears—pounds | 480,000 | 2,400 00 |
| Strawberries—pounds | 240,000 | 9,600 00 |
| Raspberries—pounds | 36,000 | 1,080 00 |
| Plums—pounds | 24,000 | 100 00 |
| Apples—bushels, green | 100,000 | 25,000 00 |
| Apples, dried | 12,000 | 6,000 |
| Cider and vinegar | | 10,000 |
| Peaches—boxes | 12,000 | 6,000 00 |
| Total value | | $ 72,430 00 |
| Value dried fruits | | 134,812 50 |
| Total | | $207,242 50 |

Fruitgrowers have met with many discouragements during the past year, but have gained in strength of purpose and increased ability, having met and overcome new difficulties. To reach the highest success in fruit culture, however, growers must learn to practice those things which all should know are essential — thorough cultivation, careful pruning, spraying, drying, or packing. Unless attention is given to all these details, one can no longer expect to reap a satisfactory reward for his toil.

L. T. REYNOLDS,
Commissioner Second District.

# REPORT OF THE COMMISSIONER.

## THIRD DISTRICT.

### SEMI-ANNUAL REPORT.

GRANTS PASS, Oregon, April 9, 1900.

*To the President and Members of the State Board of Horticulture:*

The indications for a large fruit crop of all kinds in the third district were never more promising in the history of the industry than at the present. Climatic conditions through the winter were favorable, and trees of all varieties planted in soils adapted to their growth indicated strong vitality and an abundance of bloom. Pruning the different varieties is being better understood and has been more largely practiced on intelligent lines the present season than I have ever before observed in this section.

Spraying for insect pests and fungous diseases has been done to a large extent, much more than years heretofore. I served about two hundred notices through the mail to spray and eradicate the scale, in each case inclosing a copy of house bill No. 238, and in nearly all cases the notices were complied with, or the orchards were dug up by the owners and burned. The sentiment and disposition of all the large growers is to obey the law and eradicate the pests in their orchards; but the very small growers, those with a few trees in the towns, belonging to nonresidents, I find are negligent and evasive, and are not inclined to clean their trees of injurious pests.

The question of spraying to destroy insects and fungi in the orchard is new, and many farmer-orchardists who comply with the requirements of the law do so with little faith of accomplishing the desired results. I find that when to spray, how to spray, what to spray for, and what to spray with, are enigmas to many of the farmer-orchardists. They desire to preserve their orchards from insects and fungi, but are deterred from spraying for want of faith in the results of some of their neighbors, who had sprayed and failed to exterminate or lessen the worm in the apple, or destroy the San Jose scale their trees are infested with. I have carefully investigated several of these failures in spraying, and in each case found the "neighbor who sprayed and failed" lacked the knowledge of when, what for, how, and what to spray with.

The orchardist that sprays with paris green or london purple to destroy green aphis or scale fails because he makes a misapplication of the remedy. I find many fail in spraying, where the proper remedy is used, from the fact that they spray carelessly and are not thorough in their work. Spraying with any of the remedies is labor lost unless carefully and thoroughly done. Every part of the tree sprayed must be treated with the spray to make it effective. To exterminate a fire in a building we extinguish every spark, else it would soon begin to burn again. So with the scale on our trees, we must treat every limb and spur on the tree with the spraying compound, else an untreated spur infested would in a short time infest the whole tree again. To lessen the loss from the apple worm, every apple on the tree must be sprayed to reduce the loss to a minimum.

Last year generally all over this state wormy apples were the rule. An apple free of worms was the exception. This is all wrong, and the reason the apple crop in this state was so wormy and such a loss to the growers was because so many of the large growers have not studied the habits of the moth that produces the apple worm, and have not sprayed intelligently. In many cases in this district but one or two sprayings were given for the apple worm. Probably the first spraying was too late to be effective with the first brood.

Saunders in his work, "Insects Injurious to Fruit," speaking of the codling moth, says: "The early brood of moths appear on the wing about the time of the opening of the apple blossoms, when the female deposits her tiny yellow eggs singly in the calyx or eye, just as the young apple is forming.

In about a week the egg hatches and the worm begins at once to eat through the apple to the core." Now the first spraying to be effective must occur before the calyx of the apple closes, and before the egg hatches, otherwise the poison will not reach the first egg deposit.

There is a succession of broods in this climate during the season of the growth of the apple. I have found the tiny yellow egg described by Saunders, in July, August, and September, deposited on the apple, and to preserve our apples from the worm we must spray five to six times during the season, and oftener should rains occur just after spraying.

To show that we can successfully grow the apple free of worms, I cite the success the past year of such practical men as Olwell Brothers, of Snowey Butte orchard, Central Point, Oregon. They have an orchard of one hundred and sixty acres, in apples, eleven years old. Their crop last year aggregated in value about $15,000. At gathering time last fall a careful test and assorting showed ninety-eight per cent. of their apples to be sound and free from worms, while in orchards adjoining theirs that were not sprayed during the season nearly all of the apples were wormy and a loss to the owners. In fighting the apple worm the Olwell Brothers have intelligently informed themselves of the habits of the codling moth, and their spraying was done in a thorough, scientific manner. One of the brothers was always with the spraying outfits, seeing that their orchard was properly sprayed. They used paris green and london purple in the proportion of one pound to one hundred and sixty gallons of water. The brothers told me that they made it the duty of the driver of each outfit to watch and see that the men who did the spraying sprayed every portion of each tree. The success of the Olwell Brothers last year is an object lesson to all fruitgrowers. It teaches us that an intelligent use of the spray-pump can overcome the destruction of our apples by the codling moth. They sprayed five times during the season.

During the season of 1892, at the request of the American Pomological Society, and for my own interest, I carried on a careful test in spraying for the apple worm, using paris green, one pound to one hundred and sixty gallons of water, with a little lime added to neutralize the effects of the acid on the foliage of the trees. I always was careful to agitate thoroughly before spraying each tree. I sprayed and treated ten trees

for the purpose of the test. The spraying occurred May 1, just as the apples shed their bloom; then on May 20, June 10, July 1, July 25, and August 20—six times during the season. At gathering time a careful test was made. One hundred apples were picked from each tree, and the thousand apples were all opened with the knife. Nine hundred and sixty-five of the apples were sound and free of worms; thirty-five were wormy. Only three and one-half per cent. of wormy apples, while other trees in my orchard that year that were left unsprayed, or sprayed once for the purpose of the test, showed only twenty-five to forty per cent. of the apples to be sound and free of worms.

The codling moth is with us. He is a foreign importation. We have got to beat him. We can do it with an intelligent use of the spray-pump; otherwise go out of the business of raising apples.

A. H. CARSON,
Commissioner Third District.

# FINAL REPORT.

## THIRD DISTRICT.

GRANTS PASS, Oregon, December 1, 1900.

*To the Honorable State Board of Horticulture—*

GENTLEMEN: In compiling this, my first biennial report as Commissioner of the Third Horticultural District, I meet with some difficulty in making it as complete as it should be, as my appointment dates from August 1, 1899, when I succeeded Hon. J. R. Casey, of Ashland, Oregon, resigned. The time and means at my disposal has made it impossible for me to visit all of the orchards in the third district, embracing the counties of Douglas, Jackson, Klamath, Josephine, Coos, Curry and Lake.

On assuming the duties of Commissioner of the Third District I found that my predecessor had done much valuable field work along the railroad, where the larger orchards are situated; that there was much field work to do, and a demand for information from the smaller orchardists back

from the railroad. To meet this demand a greater part of my work since my appointment has been done for the information and encouragement of the smaller growers.

I have received and answered one hundred and sixty letters from various parts of my district on subjects pertaining to the various phases of horticulture; have mailed and distributed one hundred and twenty volumes of the Fifth Biennial Report of the State Board of Horticulture among fruitgrowers, and sent through the mail two hundred notices of disinfection, with copy of house bill No. 238, to growers whose orchards were infested with San Jose scale. I found these notices of disinfection, together with a copy of the law, produced results, as men who owned orchards infested with scale were stimulated to make the effort to clean their orchards of these injurious pests. In most cases they met with success and established confidence in their minds that careful, thorough spraying, with the remedies advised by the State Board, was in their interest. Their success in destroying the scale in their orchards has put them in touch with the State Board, and their success is an inducement to a neighbor to study the virtues of spraying; hence, from now on public sentiment will largely endorse remedies suggested by the State Board, and in a short time spraying will become universal throughout this district.

Have visited and inspected about two hundred and six orchards since my appointment, with an average acreage of fifteen.

Two-thirds of the acreage of the orchards planted in Jackson and Josephine counties are devoted to apple growing, the other one-third to peaches, prunes and pears. In Douglas County the prune industry is taking the lead. The soil and climatic conditions of Douglas County is congenial to the prune, and in quality the county grows a prune that has no superior in size or flavor. The prune industry of Douglas is increasing yearly, and in time her output will be very large.

It must not be understood that because Douglas County makes the prune her leading fruit crop that she does not grow the apple, peach and pear in large quantities and fine quality.

The leading varieties of apples grown in the third district are the Ben Davis, Esopus Spitzenberg, Jonathan, Mammoth Pippin, Wine Sap, and Yellow Newtown, and Gravenstein for the fall market. Of pears, the Bartlett stands first, then Winter Nellis, Clapp's Favorite and Flemish Beauty. The

Italian and French prunes lead in acreage with some Silver and Robe de Sargent. The leading peaches are Early Alexander, Early and Late Crawfords, Susquehanna, Muir, Smolke, and Salway. All do well and are largely planted.

As to the relative acreage of fruit planted with the acreage susceptible of being planted, it is hard to make an estimate based on data in my possession accurate enough to be of any value. To get at the actual acreage planted I find an impossibility, except through a careful enumeration of the whole district, which is not possible with the means alloted me. The area unplanted and congenial to the growth of all kinds of fruit is very large, and it would be a conservative estimate to say that not over twenty per cent. of the land in the third district is now planted that is adapted to growing fruits.

In order to give anything of an idea of the fruit industry and its proportions and possibilities I can only give an estimate of the output for the three leading counties of this district—Douglas, Jackson and Josephine. Coos and Curry counties are both fruit sections but I have no data on which to base an estimate, not having had time to visit those counties:

DOUGLAS COUNTY.

| | 1899. | 1900. |
|---|---|---|
| Apples | 20,000 boxes, 45 pounds net | 35,000 boxes, 45 pounds net |
| Pears | 2,000 boxes, 45 pounds net | 4,000 boxes, 45 pounds net |
| Peaches | 10,000 boxes, 20 pounds | 20,000 boxes, 20 pounds |
| Prunes | 2,000,000 cured pounds | 2,800,000 cured pounds |
| Apples, dried | 10,000 pounds | 15,000 pounds |
| Peaches, dried | 15,000 pounds | 20,000 pounds |

JACKSON COUNTY.

| | 1899. | 1900. |
|---|---|---|
| Apples | 64,000 boxes | 100,000 boxes |
| Peaches | 120,000 boxes, 20 pounds | 3,000 boxes, 20 pounds |
| Pears | 12,000 boxes, 45 pounds | 8,000 boxes, 45 pounds |
| Prunes | 250,000 cured pounds | 400,000 cured pounds |
| Apples, dried | 50,000 pounds | 100,000 pounds |
| Peaches, dried | 60,000 pounds | |

JOSEPHINE COUNTY.

| | 1899. | 1900. |
|---|---|---|
| Apples | 10,000 boxes, 45 pounds | 30,000 boxes |
| Pears | 1,000 boxes, 45 pounds | 500 boxes |
| Peaches | 20,000 boxes, 20 pounds | 4,000 boxes |
| Prunes | 75,000 cured pounds | 50,000 cured pounds |
| Apples, dried | 6,000 pounds | 10,000 pounds |
| Peaches, dried | 10,000 pounds | 4,000 pounds |

Estimated gross output for the counties of Douglas, Jackson, and Josephine for 1899 and 1900:

| | |
|---|---|
| Apples | 249,000 boxes, 45 pounds net |
| Pears | 31,500 boxes, 45 pounds net |
| Peaches | 177,000 boxes, 20 pounds each |
| Prunes, cured | 5,557,000 cured pounds |
| Apples, dried | 191,000 pounds |
| Peaches, dried | 109,000 pounds |

The estimated gross value of the various output of fruits for Douglas, Jackson, and Josephine counties, for 1899 and 1900, at average prices for the two years named, is $444,950. This estimate is based on fruits shipped and sold out of the counties. To this gross must be added fruits sold in the local markets and used at home, such as apples, pears, peaches, prunes, strawberries, and all other small fruits, which I estimate at $50,000 in value, making a total of fruits used at home and sold to consumers abroad of $494,950.

It will be seen that Jackson County's decrease in peaches from 1899 to 1900 is very great. This decrease is due to the fact that her peach crop was comparatively a failure. The constant bearing each year in the vicinity of Ashland—the great peach-producing section of the county—caused nature to assert her rights, and Ashland's vast peach orchards struck for a deserved rest this year.

All of the fruits embraced in these foregoing estimates is from young orchards, and the output only represents their minimum producing capacities. When these orchards reach their maximum production, and the young orchards not yet in bearing become productive, I estimate the output then will increase treble what it is now.

Where does all this fruit go to? This is a pertinent question and should be answered.

Nearly all of the fruit is sold to buyers for cash, f. o. b., and is sold by them in carlots in all the markets of the United

States. Many of the apples, Yellow Newtowns, Wine Sap, Lawver (long keepers), are exported to England, Australia, Japan, and China.

Some of the larger growers in Jackson County export to foreign markets and sell in carlots to Eastern jobbers. Last season Olwell Brothers, of Central Point, sold their crop for $14,000, f. o. b. Weeks & Orr, of Central Point, sent their Yellow Newtown Pippins to Liverpool, and their returns netted them $1.00 to $1.20 per box.

The prune crop is all cured in evaporators, sold in sacks, or boxed, and is consumed in the Middle West, East, and South.

The peach output is marketed as far east as Chicago, Saint Louis, and in all the states west of the Mississippi.

### COMPARATIVE CONDITIONS.

The conditions of the orchards of the third district are improving each year in methods of cultivation, pruning, spraying, and the packing and marketing of fruit.

Many men who embarked in the business of fruitgrowing a dozen years ago had no technical or practical knowledge at their beginning. These men had much to learn. The improved conditions of their orchards, their enthusiasm over their success, and the kindly greetings they meet the commissioner with on visiting their orchards, warrants me in saying that the efforts of the commissioner has done much for the industry, and is appreciated by the mass of the growers.

Fruitmen who at the beginning could not distinguish or identify injurious insect pests, and fungous diseases, through the efforts and teachings of the State Board of Horticulture have become experts in that line, and have become teachers of their less experienced neighbors.

### SPRAYING.

Spraying for insect pests, and fungous diseases incident to fruit culture, is comparatively of recent origin. In 1886, Prof. A. J. Cook, of the Michigan Agricultural College, demonstrated its success, and since that date it has gradually increased from year to year. Spraying increased during 1900, in the third district, one hundred per cent. over any previous year since spraying was thought of. Growers whose orchards were badly infested with San Jose scale in 1899, through want

of faith, were stimulated to spray by reason of notices of disinfection sent them by myself, with the result that their orchards were freed from the scale, and their confidence established in the virtue of the remedies suggested by the State Board. Preparation is now under way, and there are but few orchards in this district but what will be sprayed this year during the winter. As confidence and faith are rapidly increasing, it is only a question of a short time when spraying will become universal. There are many growers who have made a success in spraying for the San Jose scale, codling moth, fungous diseases, while there are a few who have sprayed without success. The success and nonsuccess in spraying depends to a great extent on the personality of the grower. It is observed that two persons placed in the same physical and environmental conditions, and given an equal chance, will arrive at various results. One will succeed while the other will fail. The real directive forces that lead to success are matters of character and personality, of which the most important requisites are, love of the occupation, energy, good judgment, and careful, painstaking methods in looking after all the details of the business or work in hand.

I have made careful investigations in my district to learn the causes of success and nonsuccess in spraying, where orchards are adjacent and sprayed the same number of times during the season, with the same remedy, for the scale and codling moth. I have found these conditions to exist: The successful sprayer has prepared his spraying remedies with great care, with full knowledge of what he is to spray for, whether insect pests or fungous diseases, and when to spray. He has a good agitator on his tank that works and keeps his spraying compound in solution. If he is spraying for the San Jose scale he uses quite a course nozzle, and if for the apple worm a very fine one, so that the spray looks like a fog. He uses ample lime where he sprays with the poisons to prevent the foliage of his trees from being burnt. He applies the spray with great care and sees that the tree is sprayed from every point of the compass, so that every twig is treated with the compound, or every apple gets its proportion of poison so as to kill the young worm when it hatches. His methods are such that every scale in his orchard is killed, and his apples at gathering time are free of worms.

The unsuccessful sprayer's methods are the reverse of this. He carelessly prepares his spraying material. Has not and

will not learn the difference between insect life and fungous growth. Often I have found him spraying with bordeaux mixture for the scale and green aphis. His spraying rig is only an excuse for one; no agitator on his tank worthy the name; and his methods in applying the spray to his trees, even if his spraying compound is the thing he should use, is abominable. He uses a nozzle coarse enough to whitewash with; drives through his orchard and sprays for the apple worm with it, frantically throwing the spray in a careless way, not half spraying his orchard, and at gathering time finds the greater part of his apples wormy and infested with scale. He then attributes the success of his methodical, intelligent neighbor to other causes than the real one—spraying.

### CODLING MOTH.

Perhaps the most damaging pest the fruitgrower has to contend with is the codling moth. The loss from this pest to the apple growers of the third district will aggregate thousands of dollars the past ten years.

The habits of the moth being nocturnal, the damage is done so quietly that they are little understood by the masses of the apple growers. All conditions being favorable, an apple crop at gathering time is often found worthless from this pest.

There is much contention among the fruitmen of this district as to their ability in preventing the damage of the worm to their apples by spraying. A careful investigation of this contention discloses the fact that the careful, methodical men, who spray their orchards for this pest, market from ninety to ninety-eight per cent. of their apples in the fall free of worms, while those that do not spray, or spray in a careless way, do not market over forty or fifty per cent. of their product, the remainder being wormy and of no value. The contentious growers, who do not spray for the worm, are gradually giving way, as the facts are against them. Many of these non-spraying apple growers are like a man riding on a railroad train with his back to the engine. They do not see a thing until they have passed it. Then they see it.

As an evidence of the ability of the apple grower to contend, and successfully, and prevent the worm in the apple, I cite the results obtained by spraying by the Olwell Brothers, of Central Point. They have one hundred and sixty acres in orchard twelve years old; one hundred and forty acres are in

apples. In 1899 their orchard bore part of a crop. They sprayed five times during that season, using four and one-half ounces paris green and four and one-half ounces london purple to one hundred and twenty gallons of water, with eight pounds of lime. At gathering time a careful list was made and showed only two per cent. of apples that were wormy. The ninety-eight per cent of sound apples they sold for $14,000 that year.

This year, 1900, their crop is double what it was in 1899. They sprayed the same number of times they did last year, using the same proportions of paris green and london purple, and this year a test shows ninety-eight per cent. of their crop to be sound and free of worms. Unsprayed orchards in the immediate vicinity of the Olwells showed nearly all of the apples to be infested with worms.

Weeks & Orr, of Medford, Oregon, have one hundred and forty acres of apples bearing this year. Their methods of spraying, last year and this, are the same as Olwell Brothers'. I found, on September 25, that about ninety-eight per cent. of their apples were sound and free of worms.

In Josephine County, near Grants Pass, Hon. H. B. Miller, former commissioner-at-large of this board, now in China, has sixty acres of apples that bore a full crop this year. As to the results and success had in his orchard in spraying for the apple worm this year, I copy what his foreman says; to-wit:

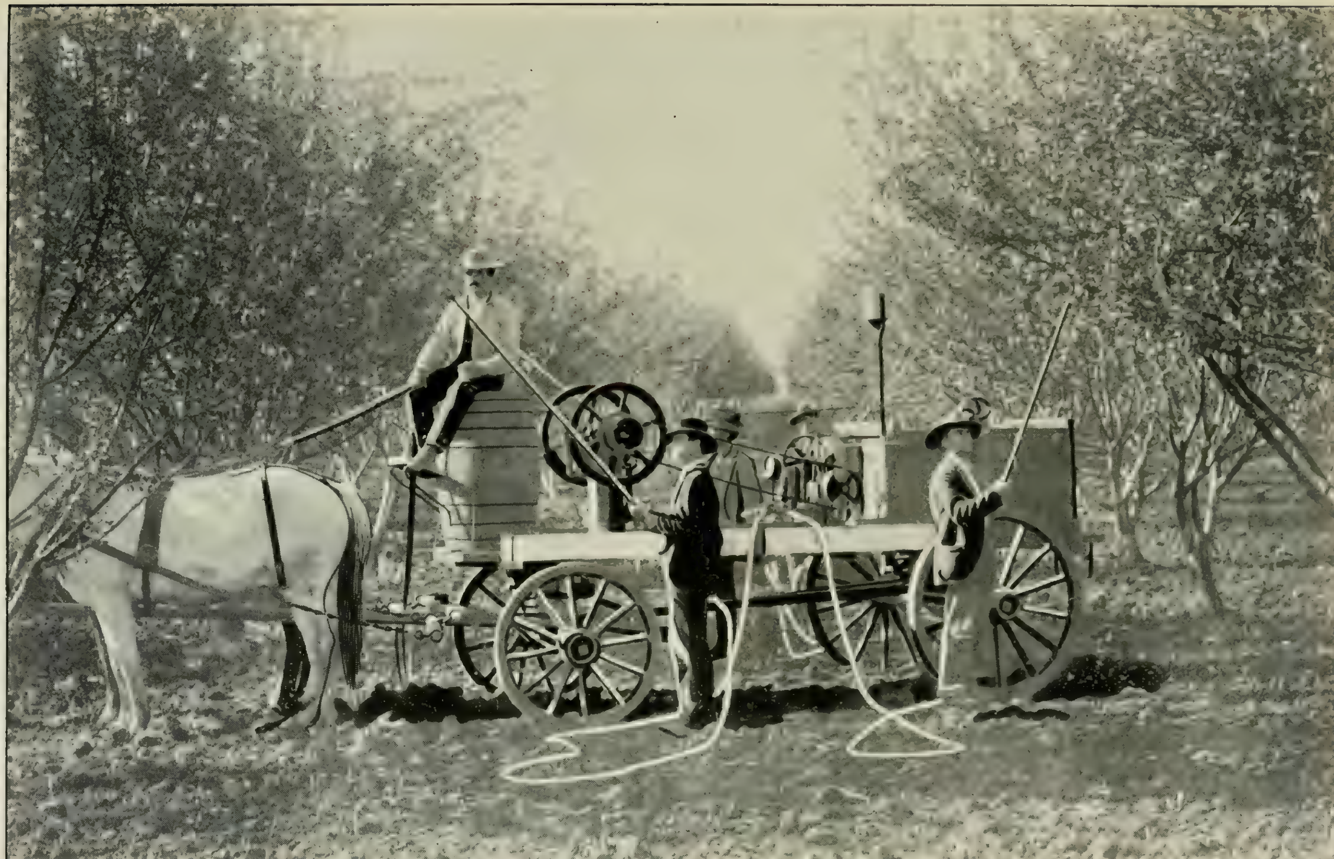
"This is to certify that I am foreman of H. B. Miller's apple ranch, and have been for three years. That the apple orchard consists of sixty acres; that the same was carefully sprayed this year five times for the apple worm, under the direction of A. H. Carson, Horticultural Commissioner Third District; that at gathering time I found only three per cent. of the apples wormy; that orchards unsprayed in the same vicinity, which I have carefully examined, show not less than half the crop to be wormy. I estimate that, by spraying for the worm this year, the apples saved from the worm will amount to $1,000 above the cost of spraying."

HENRY RUCH,
Foreman.

GRANTS PASS, Oregon, October 13, 1900.

From the foregoing certificate of Mr. Miller's foreman we see the necessity of spraying for the apple worm from a business point. In an orchard of sixty acres we find the apples saved from the worm paid for the spraying and paid a profit of $1,000 for doing the work.

The success of Olwell Brothers, Weeks & Orr and Mr. Miller in growing sound apples, free of worms, by the use of



Spraying with Gasoline Engine and four-horse. Olwell Brothers, Central Point.

APPLE ORCHARD 160 ACRES—OLWELL BROTHERS, CENTRAL POINT.


GATHERING APPLES—OLWELL BROTHERS, CENTRAL POINT.


Packing Apples for European Market. Olwell Brothers, Central Point.

the spray-pump this year, aggregating three hundred acres, is an object lesson that should convince those who do not spray that they cannot afford to ignore the facts of these growers' success in fighting the apple worm. Then, those who have sprayed, and not had the success desired, should investigate and see where their mistakes occurred, and remedy them, for they have made mistakes either in the remedies used or in their methods of spraying. I assert, from personal knowledge, that the yearly damage of the apple worm can be successfully combated by an intelligent use of the spray-pump, and the remedies recommended by the State Board, and at an annual cost not to exceed two cents for every box of sound apples.

### GASOLINE POWER IN SPRAYING.

This year Olwell Brothers, of Central Point, used a gasoline engine of two horsepower to run their spray-pump. Last year they used four spraying rigs, with a force of twelve men, to run them in their orchard of one hundred and sixty acres. This year they did the same work with four men and two teams with their gasoline engine, saving the expense of two teams and eight men. One team hauls the engine, pump, and tank of one hundred and twenty gallons capacity, with three men, one to drive and two hold the spraying nozzles. The man who drives the team observes from his point of vantage that the nozzlemen direct the spray to all parts of the tree, which assurs thoroughness. One team and man, with water tank on his wagon, hauls water to the spraying tank. The water is transferred to the spraying tank in a moment by a pump attached to, and run by, the engine. At the same time four and one-half ounces paris green and four and one-half ounces london purple and lime are put in, and the spraying pump and agitator is thrown in gear, and spraying at once begins. The loss of time in filling the spraying tank from the tender is very small, as everything about the transfer is done very quickly. The agitator on the spraying tank is geared to a bevel wheel, and run by a small shaft and pinion, and the poison at all times is kept in solution. Olwell Brothers are much pleased with gasoline power in spraying, on account of economy and their ability to do the work well. Weeks & Orr, of Medford, will use gasoline power next year, and. as gasoline power is better understood, and its adapta-

bility to spraying is demonstrated, all large orchard men will adopt it.

It is a fact that there is always a demand for the best. There is not enough of the best in any community. If the fruitgrower wants a demand for the product of his orchard he must produce the best. He must defend his orchards against fungous diseases and insect pests, and he can do so with an intelligent use of the spray-pump.

In closing this, my first report, I cannot do so without offering a few suggestions. While the fruit industry of this district is growing, representing, as it does, thousands of dollars in capital invested, with an estimated income that goes to the growers and resident labor of nearly half a million of dollars this year, the amount of means allotted the commissioner each year is not adequate to the extent of his district and labor expected of him. To cover the third district from east to west requires him to travel a distance of nearly five hundred miles airline. Only about one hundred and fifty miles of this distance can be done by rail. Orchards back from the line of the railroad must be reached by team. With the gross amount allotted—about $450 per annum—with hotel, stable, and railroad expense, which comes out of this amount, but a small amount is left to the commissioner; in fact, it makes it impossible for him to do the field work that should be done annually in the interest of the industry. Taking into consideration the fact that the fruit industry is one of the permanent industries of the state; that from year to year it is increasing, adding to the wealth of the state rapidly, constantly increasing the taxable wealth of the state, it should be encouraged and protected by liberal (not extravagant) legislation. It should be remembered the real and permanent prosperity of a country begins when agriculture and horticulture have evolved so far as to be self-sustaining, and to leave the soil in constantly better condition for plant growth. Agriculture, when at its best, remains forever in the same place, and gains in riches with the years.

A. H. CARSON,
Commissioner Third District.

# REPORT OF THE COMMISSIONER.

## FIRST DISTRICT.

### FIRST SEMI-ANNUAL REPORT.

THE DALLES, Oregon, October 9, 1900.

*To the President and Members of the State Board of Horticulture:*

Since July 1 I have visited various portions of my district, and particularly such portions as have orchards infested with the San Jose scale. This pest, so plentiful two and three years ago, is rapidly disappearing from our fruit. There was scarcely a shipment of fruit from this place this season thus affected. Still, the scale is not all gone, and, what is more or less singular, it has made its appearance to some extent in parts of the district where it has hitherto been unknown.

The majority of the old orchardists seem now to better understand the method of dealing with the scale, spraying systematically with lime, sulphur and salt, and hence experience no further difficulty in ridding their trees of the pest. A few exceptional cases are noted, however: for example, where the owners of some of the old orchards have leased their places and moved away. As the lessees occupy the premises for but a one or two year period, they are, generally, somewhat indifferent in the matter of giving proper care to the trees. Such orchards invariably suffer the dire consequences of neglect in spraying, etc. I propose next year, however, to make an example of some of these nonresidents, by seeing that the law is promptly enforced, unless they give their fruit trees the necessary care and attention to protect them from the ravages of San Jose scale, codling moth, and so on. Several growers sprayed this summer for the codling moth, but since the fruit crop was so short, a great many did not spray who otherwise would have done so. In my next quarter's report I expect to give you in detail the results obtained by the various fruit-growers from spraying. I would do so at this time, but it is a little early to present a full statement of such results, whereas, by waiting until the first of January, full particulars may be procurable.

The fruit crop, on the whole, did not come up to expecta

tions this season; at least, the fruitmen generally expected a larger crop. At the same time, the prices obtained for the fruit have been quite satisfactory to the growers, and they seem to have no complaint to make on that score. The suggestions which I offered to fruitgrowers at our meeting in June, that they load their fruit into the cars and sell the same outright to some fruitbuyer who is on the ground, thus being relieved of the burden of assuming all risks incident to shipping east on commission and upon their own responsibility, I feel has been as seed sown in good ground. The majority of the shippers in the vicinity of The Dalles disposed of their fruit in this manner here this summer, obtaining good prices for it. I certainly believe that that is the safest and best way to handle large consignments of fruit, and will be the only way in which fruit will be shipped in the future. Shippers are becoming weary of taking chances on dealing directly with the Eastern commission houses, paying freight bills, and, possibly losing their fruit, etc., as has been the case in several instances in the past. The best way, as I have advised, is to dispose of the fruit to a buyer as soon as the car is loaded.

I have found this season that the Italian prune trees are badly affected with a peculiar kind of a blight, and I am as yet unable to determine the real cause therefor. The blight seems to have left its damaging traces upon the leaves of the trees. In going through an orchard I have found here and there a tree thus affected. The soil for the one tree being of a different substance than that for the other, and all other conditions being proportionally rational, some trees would be perfectly sound while others were considerably damaged. I noted this singular blight, some time ago, upon tomato plants, where, in a hill containing two plants, one would be badly affected with the blight, while the other appeared perfectly healthy and productive. It is a mystery to me to determine to what source this leafy blight might be attributed.

Another circumstance that gives us annoyance in the eastern part of this district is the constant dying back, annually, of many of the fruit trees, especially apple trees. For the past ten years this has been noticed in orchards planted on bunchgrass land, where the younger growth of the trees have died back every year. A new growth comes up which dies back in the succeeding year. Some of the trees fail to manifest anything of this nature until after they are four or five years old. I am unable to ascertain the

cause of this trouble. In some cases, however, I think I have found the difficulty to be in the soil. Wherever I find an underlying strata of alkali soil I am pretty sure to discover a hardpan subsoil from eighteen inches to two feet below the surface. Blight, I consider, would be a logical consequence in trees grown upon such ground. But again, in other places, where the soil and every other condition seemed favorable for the growing of the tree, this same blight would make its appearance sooner or later. The limbs of some of these trees I have sent at times to the experiment station at Corvallis, but it seems that the people at that place were hardly in a position to discover the cause of the blight. They usually recommended that we trim back to the affected portion of the limbs. This has been done, only to result the next year in the growth of the tree acting in the manner above described.

In my travels during the summer, I found a new kind of aphis, of a darker color and much larger than the common green aphis. This insect got after the cherry trees principally, which fact, I think, is accounted for by the coolness of the summer. The aphis seemed to prefer to commit its depredations during cool weather rather than in the very warm season.

I am firmly of the opinion that one of the greatest needs of this state, at least so far as horticulture is concerned, is the permanent assignment of some competent person, an expert, whose sole duty it should be to treat upon the various fungous diseases that are peculiar to Oregon fruit; for example, the apple canker, the pear blight, the tomato blight, etc. Several of these specialists are stationed in different sections of California, and it seems to me nothing would be lost by having somebody in Oregon to cope with the difficulties that constantly confront the orchardist as well as the fruit commissioners, who are not generally in a position to deal with these things as would an expert. Of course, we have the experiment station at Corvallis, but the fact is that the professors there have not sufficient time to properly attend to such cases of diseased fruit trees as come to their notice; hence the need of a man to devote his undivided attention thereto. Two of such experts would not be too many. One might be stationed in the western part of Oregon, or Washington for that matter, somewhere west of the Cascade Mountains. Another might give his time to the fruit in Eastern Oregon and Washington.

Under such an assignment, I am sure each man would find sufficient work to keep his time occupied. In Eastern Oregon, especially, a competent fruit specialist would have his hands full for a while, analyzing some of the soils in which our orchards are grown. Some carelessness is clearly apparent in the eastern part of my district, where many trees are suffering because of having been set out in soils by no means adapted to the growing of fruit—and a specialist, if he were in the field now, might be directly instrumental, by an analysis of the soils, etc., in remedying all such mistakes. Thus, in the course of a few years, the fruit sections east of here would be prosperous and thriving, where they are now so wofully scant and unprofitable.

EMILE SCHANNO,
Commissioner Fourth District.

## SECOND SEMI-ANNUAL REPORT.

THE DALLES, Oregon, April 9, 1900.

*To the President and Members of the State Board of Horticulture—*

GENTLEMEN: The following is a statement of my work and observations for the last six months:

I find the prospect for a good fruit crop in my district the best that I have ever seen for this time of the year, and most especially the peaches and cherries; and, if we do not have any frost later on, this class of trees will have to be thinned out, or else by reason of the heavy bearing this fruit will be very small and hardly fit for market. The danger of frost, however, is very remote, as there is very little snow along the foothills and the mountains to cool off the air and thereby cause frost.

The fruitgrowers in my district have already been spraying this winter and spring, as the weather has been very mild and warm and particularly favorable for this kind of work. The fruitgrowers are taking better care of their orchards than in former years, as they have begun to realize that it pays to take the best care of their fruit trees, and especially so when apples are worth from $1.50 to $1.75 per box. As an evidence of this fact, I now find spraying pumps and spraying apparatus wherever I go, when but a few years ago it was a very rare thing to see a spray-pump in an orchard.

There are several fruitgrowers in my district who are mak-


131.—HOOD RIVER APPLES.

ing a success in spraying for the codling moth. One grower especially, Mr. C. Sayers, of Hood River, saved about ninety-five per cent. of his apples last year by spraying, and his apples brought him from $1.50 to $1.75 per box, although they were of the Ben Davis variety. Some fruitgrowers may say that this was mere luck, but I consider it no luck at all, but merely the result of the care he took of his trees, as those of his neighbors who did not spray hardly had any apples at all but what were wormy. I shall endeavor to obtain a correct statement from Mr. Sayers in the near future showing the number of times he sprayed his orchard, and what kind of spray he used, and also the price he realized for his apples.

The output of apples this year in my district will be greatly increased from that of former years, as there is in the neighborhood of four or five hundred acres of young trees that are from five to six years old, and will come into bearing this summer. They are mostly all in large tracts, and if nothing happens, I am satisfied there will be from seventy-five to one hundred carloads of apples shipped out of here this next fall.

Respectfully submitted,

EMILE SCHANNO,
Commissioner Fourth District.

# FINAL REPORT.

THE DALLES, Oregon, December 1, 1900.

*To the Honorable State Board of Horticulture —*

GENTLEMEN: I respectfully submit to you herewith my report as Commissioner of the Fourth Horticultural District, from January 1, 1899, to January 1, 1901:

My district comprises the following counties: Sherman, Wasco, Gilliam, Morrow, Wheeler, and Crook.

To attempt to give anything new in my report of the horticultural condition of my district is quite difficult, as I have gone over this same work about four or five times in the last ten years and there is hardly anything new. There has not been a great many changes in my district in the last two years. The fruitgrowers are improving and they understand the planting, and the soil, and the variety of fruit better at

this time than they did a few years ago. They learn a great deal by experience and a good many learn from their neighbors.

In the last two years I have visited five hundred and eighty-one orchards. I have not visited all the orchards in my district but have made it a point to visit the principal orchards, and especially those that were affected with the San Jose scale and other insects.

That there is a growing interest in horticulture is manifested by the number of letters received pertaining to that subject; the number which I have received being two hundred and seventeen in the last two years, from different parts of the country.

As to the acreage of fruit in my district, it is very hard to get at, as there is a large acreage in small orchards that I have not visited at all, but I should judge there is approximately four thousand to five thousand acres in fruit. About seventy-five per cent. of this is in Wasco County.

The variety of fruit grown in my district is about sixty per cent. in apples, about twenty per cent. in prunes, about ten per cent. in peaches, and about ten per cent. in other varieties, such as pears, cherries, and grapes, as every locality has different varieties of fruit.

I should judge there is not over twenty per cent. of the land in fruit that is suitable to fruit. In my district there is a large amount of land lying along the Columbia River that would raise excellent peaches and grapes. There is also a large amount of land in the foothills of the Cascade Range, and in the foothills of the Blue Mountains on the west side, in Morrow and Crook counties, that would raise excellent apples for commercial purposes. There is a large percentage of land suitable to apple growing that is not yet taken up on account of it being too far from transportation.

There are fruitgrowers in some of the localities who raise fruit only for home use, and they are not taking as good care of their orchards as those who are growing fruit for the market. In all parts of my district, where there is fruit raised for commercial purposes, they are taking better care of their orchards than when they raise it only for home consumption.

I find it is very poor policy to let an orchard run down. Last year there was a very small fruit crop, and in some localities no fruit at all, and they have taken hardly any care of their orchards.

There has been a great deal of progress made in my district in the last two years in spraying. You will find that about eighty per cent. of the growers have spray-pumps, and especially in the Hood River District they have made great progress in spraying for the codling moth. There are some of the fruitgrowers that save as much as ninety-five per cent. of their apples; others have not done quite so well. I think the cause of it is that they have not given the matter as close attention as they should have done. I noticed where the trees had been sprayed with a heavy coat of lime they had better results than those who had used less lime. I believe that the lime is a preventive for the codling moth. The fruitgrowers have also got a better price for their fruit in the last two years than they have before.

There is very little fruit shipped from here on consignment. Most of this fruit is sold for cash f. o. b. There were eastern buyers in the market this summer who bought our prunes, and they were ready to pay for it as the fruit was delivered to them.

There are three things that are most important to any one starting into the fruitgrowing business:

First—Planting an orchard. In planting an orchard ninety-five per cent. of the beginners make a mistake by planting their trees too close together. A great many plant their trees from fifteen to twenty-five feet apart, and this is one of the most serious mistakes they can make. I have seen orchards that were from twelve to fifteen years old, and they were already at their best and the trees were dying. The limbs had interlocked one another, so that you could not get through it, and the fruit was of a very small, inferior variety.

Any one who contemplates planting an orchard should study the rainfall in the locality. In the largest portion of my district the rainfall is only fourteen inches, and you will readily see that that is hardly enough for a tree to mature its fruit, if they are planted so close together. Apple trees should not be planted any closer than thirty or thirty-five feet, and forty feet would be better. Downing says fifty feet. Pear trees should be from twenty-five to thirty feet apart, and other kinds of trees should be no closer than twenty-five feet. About ninety per cent. of the fruitgrowers whom I visit say to me, "I made a mistake and can see it now; I planted my trees too close together."

Second—Variety of fruit. One should be very careful and

find out what variety of fruit is best suited to the market, and also what variety would do the best in that neighborhood where he intends to plant his orchard; and also study the soil. After an orchard is once planted, and two or three years old, then it is too late to correct the mistake. I have noticed some of the fruitgrowers who made this mistake started to topgraft, but they had better cut some of the young trees down than to try to topgraft, as they can never make an orchard; I have seen that tried often.

In planting a tree most of the fruitgrowers are not careful enough, and they plant too deep. The better way would be not to plant deep enough. The ground on which you intend to plant an orchard should be subsoiled at least eighteen inches deep, and the ground should be well underdrained so that the water will not stand about the trees in the winter time.

The varieties which I find do well in my district, and are the best for commercial purposes for early summer, are the Red Astrachan and the Gravenstein. These are the very best. If you are handy to market, or a railroad or steamboat, I would advise you to raise these varieties.

For a fall apple there is the King and the Canada Renet. These are very good apples for the fall trade. The Spitzenberg, the Genitian, and the Yellow Newtown, are the three very best winter apples, which will sell when nothing else will sell. There are buyers in the market who will buy Spitzenbergs when they will not buy anything else.

Third—Pruning and cultivating. There is one very important thing, I find that some of the fruitgrowers go to extremes both ways. Some prune their orchards too much, and others not enough. But I had rather take my chances with an orchard that was not pruned at all than one that was pruned too much, and especially apples. An apple tree should never be pruned after the second year from planting. The tree should be shaped as it is wanted to be and never have anything done to it afterwards, only to take off in the summer months some of the water sprouts that happen to come out. I read in an article in a German horticultural paper last summer, of a meeting in Germany, at which a professor remarked that there was more injury done to fruit trees by the knife and saw than anything else. This has reference to the trimming of apple trees, pears, and cherries; prunes and peaches can hardly be trimmed too much.

I find some of the fruitgrowers, when they plant a young orchard, start to top their trees about two feet from the ground, and three or four years afterwards they find out they have made a mistake, by growing their trees too low to the ground. I would consider the best way in starting an apple tree would be to cut it not less than four feet from the ground.

I find a good many orchardists that have been heading their trees too low, and in about three or four years afterwards they find it out to their sorrow. Then some of them undertake to cut off these lower limbs and try to head their trees higher; but I would not advise anyone to do that. They had better let them alone, or grub them up, as they will never make a tree again.

In starting a young orchard you want to be careful and get good healthy trees, not less than five feet in height, and about the size of the stock of a buggy whip, and, if possible, get trees that were grafted on whole roots, and not on pieces of roots; and get the very best. Never undertake to buy cheap trees. In Germany the trees that are grafted on pieces of roots are sold from thirty to thirty-five per cent. less than trees that are grafted on whole roots.

There is one important matter in cultivating an orchard: I find that some of the fruitgrowers plough their orchards too deep, and a person should use good judgment in cultivating an orchard. Where the soil is shallow, and the roots are very close to the top of the ground, you should never plough that orchard; the harrow is the best thing to use. In an orchard where the soil is deep, you might plough, but never over six inches deep. You must keep up the cultivation of your orchard until the first of August. You should run some kind of a cultivator or harrow through it about twice a month; after that it is not necessary to cultivate it any more.

There are a good many orchardists who are struggling against nature, trying to raise an orchard on land that is not suitable to grow fruit on. That is the land which is called bunchgrass land. If it was natural for a tree to grow there, nature would have made one grow. I do not find many orchards that are over six or eight years old on bunchgrass land. As soon as they strike what is called hardpan the limbs begin to show it on the top of the tree on the young growth, and it dies back every year. There are some localities on bunchgrass where trees do very well. For instance, on the flat, or on some of the north hillsides, where the soil is deep, you

may raise trees. I also find a good many peach trees and prune trees that do very well. Almost any kind of a tree that is grafted on a peach root does better on bunchgrass land than any other kind of a tree. The reason of that is they have no deep roots.

There was a large fruit crop raised in my district this year that was not so much on account of the older orchards, but there was a great many young orchards began bearing this year.

As to the amount of fruit shipped from my district, I could not tell exactly ; but there were about forty cars of prunes and plums in the green state, then there is about ten cars of dried prunes that will be shipped, and some that will be used here in the local market, and about eight carloads of pears. There were about ten thousand boxes of apples shipped from here from different localities ; but the largest amount of apples are still in the hands of the growers. There were also a great many peaches and grapes shipped. This has reference only to The Dalles. I think there was about as much fruit shipped from other localities in my district, say Hood River, Mosier, Grants and Blalocks.

Often the question comes up in my district, whether manuring an orchard is a benefit or whether it is an injury. My experience is this, that I would not advise anybody to put fresh barnyard manure on an orchard, as I believe it to be injurious ; but a well-rotted manure will be all right. In the last two years I have found two orchards in my district that were planted side by side ; the same variety of fruit, the same soil, and planted at the same time. One of the orchards has had a good deal of care and cultivation, and also had a good deal of manure hauled into it, while the other orchard has had hardly any care at all ; and this orchard has produced about five boxes of apples, while the other orchard has produced but one box, and trees on this orchard have mostly all died out. I give my reason for that that it had too much barnyard manure hauled into it. I tried the same experience in my orchard, where I put some barnyard manure about a tree, and the second year I noticed that the tree was not doing well, and the limbs began to show signs of decay ; and for that reason I think the fresh barnyard manure is an injury to a tree.

As to laws governing the State Board of Horticulture, I think it would be a good idea if the laws were changed so as

to have a commissioner in each county, appointed by the county court—the same as the stock inspectors are—and to be paid by the county in which this commissioner resides, or there should be more commissioners. I find my district is too large for one man to undertake to visit all the orchards. I think there should be four more commissioners in Eastern Oregon. Two should be east of the Blue Mountains, and two west of the Blue Mountains, say between the Cascade Mountains and the Blue Mountains.

EMILE SCHANNO,
Commissioner Fourth District.

# REPORT OF THE COMMISSIONER.

## FIFTH DISTRICT.

### FIRST SEMI-ANNUAL REPORT.

COVE, Oregon, October 9, 1899.

*To the President and Members of the State Board of Horticulture:*

I herewith submit to you my first semi-annual report of the fifth district. I have visited all of the larger fruitgrowing districts in Union, Baker, and Malheur counties, except the Burnt River district in Baker County. In the latter part of July I visited Malheur County and was greatly susprised to find so many large and thrifty orchards in that part of the state. I visited the orchard of the K. S. D. Fruit Land Company, situated seven miles south of Ontario. This orchard is on the line of the Oregon Short Line Railroad and is all under the great Owyhee ditch. About one hundred acres of it are in prunes, seventy-five in winter apples, twenty in pears, and ten in assorted fruits. The entire two hundred acres is on level ground, and, with the exception of two trees that had woolly aphis (which Mr. Danielson, the manager, immediately destroyed), the orchard is free from fruit pests. I had been earnestly requested by these people to call on them, as they had never had a visit from a commissioner of this district, and at that time (the first of July) an apparently fatal disease had struck a forty-acre four-year-

old apple orchard. After seeing the trees, I decided it was undoubtedly a winter kill, and advised them to try trimming out all of the water-sprouts but five or six, as these were forcing out by the hundred near the crotch of the trees. If it were winter kill this would have a tendency to force the growth to the upper limbs that were lying dormant. I received a letter a few days since from Mr. Danielson saying the entire orchard had come out in first-class condition.

Adjoining the K. S. D. Company is the Ontario Fruit & Nursery Company. Certain varieties of their trees were affected the same way. Mr. Van Gilsey, the manager, was not at home when I called and I do not know if they gave their trees the same course of treatment or not.

At Huntington I took a team and traveled down Snake River twelve or fifteen miles. The orchards all look thrifty in that district, but I was informed that the codling moth was obtaining quite a foothold in their orchards. It ought not to be a difficult pest to subdue, as their orchards are young and miles apart.

In Powder River Valley the orchards are not large and are apparently quite free from pests.

In Grande Ronde Valley there is some moth. A good deal of spraying has been done, but, as the crop is very light, it has been difficult to get a certain class of growers to spray with no returns in sight.

I have condemned two shipments of pears that were literally alive with San Jose scale. They were from Walla Walla and were shipped by different firms. I wrote to them requesting them to send no more such fruit to this country or I would be compelled to adopt stringent measures in regard to it.

JUDD GEER,
Commissioner Fifth District.

## SECOND SEMI-ANNUAL REPORT.

COVE, Oregon, April 6, 1900.

*To the President and Members of the State Board of Horticulture—*

GENTLEMEN: I herewith present you my second semi-annual report of the fifth district:

My work during the six months just past was confined to Umatilla and Union counties. On the twenty-fourth of February I left Cove to make a tour of Umatilla County. I met

Prune orchard of A. A. Belden, Cove, Grande Ronde Valley, Eastern Oregon. Six hundred and twenty-five eight-year-old trees produced forty-four tons of fruit in 1900.

President Miller in Milton on the 26th, and during that week I inspected orchards in the vicinity of Freewater and Milton.

I find the San Jose scale is being subdued to a great extent, as nearly all orchardists are spraying for it thoroughly, but there is almost nothing being done to exterminate the codling moth, and I was informed that it was very hard to obtain an apple in that section last season that was not infested with a moth. It is a bad state of affairs, and the people are apparently of the opinion that it is useless to spray for it. I also found strong indications of apple canker in some of the orchards.

In and around Pendleton the orchards are mostly small and in good condition. At La Grande and Union the orchards are in good shape, about the only disease noticeable being crater blight on pears.

I was greatly surprised a few days since to find a young orchard in Cove literally ruined with apple canker. The trees came from the Willamette Valley and were planted three years ago. Fully fifty per cent. are now dead, and twenty-five per cent. dying.

JUDD GEER,
Commissioner Third District.

# FINAL REPORT.

## FIFTH DISTRICT.

COVE, Oregon, October 27, 1900.

*To the President and Members of the State Board of Horticulture:*

GENTLEMEN: Permit me herewith to present to you my first biennial report:

The fifth district comprises the counties of Umatilla, Union, Wallowa, Baker, Malheur, Grant, and Harney. In extent it embraces nearly half the territory of the state. Mr. Schanno, the commissioner of the fourth district, very kindly consented to relieve me of the work in Grant County, and as it adjoined his district the board decided that it was advisable to give that portion of my work over to him.

My commission dates from April, 1898, hence my work extends over a period of one and one-half years. During that

time I have received two hundred and twenty-seven letters and visited four hundred and seventy-eight orchards, with a combined area of twenty-four hundred and seventy-six acres, which is probably less than one-fifth the acreage of the district. There are few sections in Eastern Oregon where the farmer cannot grow in abundance all the hardy deciduous fruits, and in many localities the more tender varieties. Apples, pears, cherries, prunes, plums, apricots, peaches, and grapes abound. Berries of every variety seem to flourish, and in some favored places tomatoes and melons are grown and shipped by the carload. It is not so much a question of the kinds of fruit which may be grown as the special varieties which are of greatest commercial value. There are many things to be considered before entering into the business in a commercial way. Experiments and mistakes are expensive when conducted on a large scale, hence one cannot study too carefully the location, soil, climatic conditions, likewise the varieties, marketing, freight, etc., at the outstart. The fruit industry is yet in its infancy. Every year demonstrates more clearly that the larger the supply of good fruit we have, the better it is for the producer. We find more buyers in the field, and, all things considered, better prices rule. Of no product of the farm is it more apparent that we must not only have a choice quality, but must have it in large quantity to enter the world's best markets. Cheap and rapid transportation we must have, and that can only be obtained from the transportation companies by sending large quantities.

Two years have made some important changes in my district. Many fruitgrowers that had not enough apples for family use two years ago are now gathering in their crops, estimating them by the carload. A few instances that have come under my immediate observation: One man with a ten-acre apple orchard of five-year-old trees has four carloads of choice apples; another, with a twenty-acre apple orchard of trees the same age, has ten carloads. I do not like to make an estimate of the apple crop of 1900; I am afraid of making it too small. If the actual yield could be determined this early in the season, I am sure it would astonish many people.

The owners of young orchards are more than ready to adopt new methods, and anxious to learn in every possible way. I have had many requests, both in person and by letter, for copies of the fifth biennial report, from those who wished to own a copy. Some have expressed surprise that so able a

work on the subject could be distributed gratuitously, and, rarely, I believe, has a state report found a more appreciative class of readers. But there is one class of fruitgrowers hard to reach. Their orchards and dooryards are prolific breeding places for many dangerous foes to the fruit industry. Nothing will help to convince them so much as a practical illustration. When they have seen a few of their more progressive neighbors reap a clear profit of $100 per acre from well-kept orchards bearing clean fruit, they will begin to understand,—and many are being convinced this fall in my district from just such illustrations. I believe a majority of the fruit pests are more easily subdued or exterminated in our climate than where the atmosphere is more humid. We do not have so many broods of codling moth, the later broods doing the most damage. The San Jose scale is diminishing, and in some places is entirely gone. Owners of commercial orchards are quite generally willing to spray. A carelessness exists on the part of those "who see no money in it" that is hard to overcome. In several instances I have found diseased fruit in the market and I had the fruit and packages destroyed. I find the dealers quite ready to co-operate with the horticultural board in enforcing the law.

One of the first fields to which my duties as commissioner called me, was to Ontario, Malheur County. The K. S. D. Company requested me to examine some of their young orchards, which were not doing well. The trouble proved to be, not a disease or blight, but the effects of the severe winter of 1897 and 1898 that had partially winter-killed some of the more tender varieties. I advised them to trim the trees freely, cutting out besides all dead wood the water-sprouts, and later received a letter from the manager to the effect that the desired result was obtained, and that the trees were assuming a normal condition again. My visit was indeed a surprise and pleasure. There are some large orchards in the vicinity of Ontario, notably those of the K. S. D. Company, of one hundred and thirty-five acres, and Mr. Van Gilsey's, of one hundred and seventy-five acres. They are under a fine system of cultivation. The land originally belonged to the arid lands of Eastern Oregon, and has been brought into productiveness by means of irrigation. The soil, climate, and everything here is especially adapted to fruit culture. They claim to have produced apples weighing twenty-four ounces, and peaches measuring twelve inches in circumference, on this

land. The ditch covers twenty-five thousand acres of land apparently susceptible of high cultivation. Another ditch is being put in which will cover forty thousand acres when completed. Possibilities not dreamed of for Eastern Oregon would come with the development of this vast tract of land. The culture of fruit should play no insignificant part.

A few months later, I visited the valleys of Eagle and Pine, and some scattering orchards that lay along my route. We found some good orchards at Medical Springs. Pine Valley has an altitude of three thousand feet. There are a good many young orchards. Apples and pears excel all other fruits in quality and quantity. The growers find a good market for their surplus in the neighboring mining camps. Their great distance from a shipping point would hamper the industry if fruit was produced in large quantities. Eagle Valley is a veritable little paradise for the fruitgrower. The soil is wonderfully prolific, and the condition for irrigating ideal. All kinds of fruit suited to our climate mature to perfection. It partakes of the nature of the Snake River fruit lands. The valley is small, and every available spot under cultivation. A specimen of their apples which I saw this year measured seventeen and one-half inches.

The Milton fruit district is probably the best-known of any portion of my district, and deservedly so. I visited some progressive orchardists in this vicinity. In no part of my district do grapes mature so perfectly; even the Flaming Tokay, the Muscat, and Muscatel, may be grown here. All of the deciduous fruits thrive, and may be grown with profit. It is likewise a convenient shipping point. There are many thousand acres in this portion of the Walla Walla Valley awaiting the progressive orchardist. The nurseries I found here were clean and in excellent condition. This section has been much troubled with both the San Jose scale and codling moth. Many of the orchardists have made a determined and intelligent effort to keep their orchards clean, with most gratifying results, but there are still only too many who are grossly careless.

Wallowa County has little of what might properly be called fruit land, however, I saw some very nice orchards, and there is a ready market at home for more than they can produce. Apples, pears, prunes, and plums, of hardy varieties do well along the foothills. The Imnaha Valley in the extreme eastern part of the county has the Snake River climate, and produces

peaches of fine quality. It is difficult of access, and what fruit is grown is hauled in wagons, and distributed over the surrounding country.

Harney County, I have not visited, but I understand there is very little fruit grown there. It is principally a stock country.

Grande Ronde Valley being my home in the district, I, perhaps, see fewer of its faults and appreciate its advantages more fully than do some, hence I will not write at great length. About the foothills there is an almost unlimited supply of desirable fruit land. Apples, pears, plums, and prunes, of all varieties do well. It surprises some to know that we can produce sweet cherries that in size, color, flavor, and firmness, cannot be surpassed. They ripen in August and enter the eastern markets after the California fruit is gone.

There are some beautiful young orchards situated near the river, a few miles from La Grande, also about Summerville, Cove, and Union. Indeed, there are good commercial orchards at all of these points, and there is hardly a home about the foothills of the valley but is supplied with more than its inmates can consume from a family orchard of mixed fruits.

Eastern Oregon possesses many substantial advantages to the commercial fruitgrower. First, the trees come into bearing at an early age. A difference of even one year (and in many instances it is a difference of three or four), is of no small consideration when one is waiting for returns on an investment. Second, the land is cheap, not to be compared in price to land in places that have become famous for their fruits, and yet our fruits often surpass theirs in many points. Third, our fruits stand up well for shipment. The cool nights which we have give to our fruits a firmness unknown to those grown where the nights are hot. And last, and by no means least, our fruits reach the market after it has ceased to be overstocked, and while they may never reach the fancy prices brought by the first fruits of the season, they will come as a refreshing surprise on the heels of the last run of soft fruits from the warmer districts.

There are about four hundred and fifty-six thousand acres of land under cultivation in the fifth district, twenty per cent. of which would prove profitable if devoted to fruitgrowing. Only about three per cent. is now in orchards. The fruit crop for 1899 was as nearly a failure as has ever been known. We had a home supply and shipped about fifty carloads from the district. They were mostly apples.

The four counties named below are those having commercial orchards:

IN CARLOTS.

| Counties. | Apples. | Fresh prunes. | Peaches. | Pears. | Strawberries. | Blackberries. | Cherries. | Evaporated prunes. |
|---|---|---|---|---|---|---|---|---|
| Umatilla | 165 | 25 | 3 | 12 | 8 | 3 | 3 | 20 |
| Union | 140 | 20 | 1 | 5 | 3 | 1 | 2 | 20 |
| Baker | 25 | | 3 | 1 | | | | |
| Malheur | 35 | 5 | 2 | 2 | | | | 3 |

Respectfully submitted,

JUDD GEER,
Commissioner Fifth District.

# REPORT OF QUARANTINE OFFICER FOR COOS AND CURRY COUNTIES.

MARSHFIELD, Oregon, May 31, 1900.

*To the State Board of Horticulture—*

GENTLEMEN: I herewith submit my report as quarantine officer of Marshfield, Coos County:

After my appointment I caused the publication of the quarantine regulations in a newspaper, and posted them at four different places in the county and also on the courthouse.

A large shipment of nursery stock arrived in Marshfield from Ontario County, New York, shipped by May & Company, the apple trees of which were infected with the woolly aphis, the pear trees by a bark disease similiar to the crater blight, some also by the pear blight, the cherry trees of the sweet varieties by the gummosis, the raspberries by the anthracnose, and the peach trees showed indication of the peach-yellows. A certificate of inspection from the state agricultural inspector of that state accompanied the shipment. I have burnt the pear, cherry and peach trees, also the raspberries, and ordered disinfection of the rest, which was duly carried out. After

subsequent inspection and disinfection I allowed them to be delivered. Knowing from experience that the woolly aphis has been carried by nursery stock on which it does not feed, when packed together in bunches or boxes with infested apple trees, I ordered the disinfection of the whole shipment.

Finding out that a shipment of trees from the same firm went to Myrtle Point, I telephoned to the railroad agent of that place to hold them until I came up. These trees were also infected with the same pests and diseases like those inspected in Marshfield, and, disinfection being refused, I have burnt the whole shipment.

When in Myrtle Point I was informed of a shipment of trees from a Woodburn, Oregon, nursery, and in possession of delivery agents. Not having found any inspection certificate attached, I examined them and found the woolly aphis. I ordered disinfection, for which I gave directions. The disinfection being delayed, I notified the nursery firm, and in answer it solicited me to secure for them a person who would be capable of doing the disinfection, or, if possible, doing it myself, for which it offered compensation, Not having been able to find a person, I concluded to accommodate the nursery firm, but when coming to Myrtle Point I found the trees dried up. I notified the firm about the matter by telephone and destroyed the trees. The nursery firm, believing my function uncaused, sent me a letter containing an unpleasant accusation which I inclose for examination.

Shipments of trees from the State of Washington, accompanied by inspection certificates, I have found free of insect pests and diseases; also trees from the Tangent Nursery Company held at the railroad depot in Marshfield for want of an inspection certificate.

In conclusion, I would state that the citizens of Coos County are recognizing the importance of the quarantine regulations and favoring the enforcement of them.

Very respectfully,

ANTON WIRTH,
Quarantine Officer.

# REPORT OF THE SECRETARY.

*To the Honorable State Board of Horticulture—*

GENTLEMEN:

"The Father of humankind himself ordains
The husbandman shall tread no path of flowers,
But waken the sleeping land by sleepless pains,—
So pricketh he these indolent hearts of ours,
Lest his realms be in hopeless torpor held.

* * * * * * * * * * * *

And all these things he did,
That man himself, by pondering, might divine
All mysteries, and, in due time, conceive
The varying arts whereby we have leave to live."

—*Virgil.*

Agreeably with my duty, permit me to hand you a report of the workings of this office since my appointment as secretary of this board, at your annual meeting held at Salem in April, 1899.

This was a very notable meeting in many ways, as both the then president and secretary retired, both tried and valued officers—President Cardwell having held that position ever since the board was organized, ten years ago. Under the new law, which necessitated the president visiting the orchards in person, the position required more time than he could give to the fruit interests, hence his resignation. In presenting his successor, Hon. H. B. Miller, Doctor Cardwell spoke at length on the condition of fruit interests, on the initiation of the present law, and concluded with wise suggestions for the future administration and success of the board.

Mr. Miller thanked Doctor Cardwell for the many kind words spoken and courtesies shown him, and feelingly alluded to the valuable labors of Doctor Cardwell as a horticulturist and president of the board, which he said were duly appreciated by the fruitgrowers throughout the state, and highly creditable to him as a citizen.

Commissioners Lloyd T. Reynolds and Henry E. Dosch, who had been appointed a committee, presented the following

RESOLUTIONS.

WHEREAS, The duties of the President of the State Board of Horticulture have been greatly enlarged by an act of the last legislature; and,

WHEREAS, President J. R. Cardwell, owing to his large private interests, feeling that he is unable to continue in the office which he has filled so long without sacrificing his personal interests, has tendered his resignation to the Governor; and,

WHEREAS, Our venerable and efficient secretary, John Minto, after four years of faithful service, has seen fit to resign his office, therefore be it

*Resolved*, That in our pleasant relations with these gentlemen, both officially and socially, we have learned to admire their high character and integrity as men; that for their pioneer efforts in horticulture, which have assisted in making fruit production one of the leading industries of our state, Oregon owes them a debt of gratitude; and,

*Resolved*, That to Dr. J. R. Cardwell, for the faithful discharge of his duties as president of this board for the past ten years, which has been purely a labor of love for our horticultural interests; and to John Minto, for his diligent work as secretary and especially for his valuable efforts in behalf of our forestry interests, we tender our most sincere thanks, and while we regret to sever our cordial official relation, we wish to express our hearty interest in their future welfare.

*Resolved*, That these resolutions be spread upon the minutes of this board, and a copy be sent to each of our late associates.

At this meeting it was also resolved that the fruit interest would be better subserved if the office of the board was located at Portland, in the center of the fruit business, and, agreeable with this thought, the office of this board was located in the Chamber of Commerce Building, without expense to the state.

In the withdrawal of Mr. Minto from the labors of the office as secretary, the board lost a valuable and efficient official—one on whose judgment the members always relied, and who was largely instrumental in making the board as effective as it has become.

My selection as Mr. Minto's successor as secretary of this board necessitated my resignation as commissioner for the first district, and, agreeable therewith, I sent in the following resignation: —

*Hon. T. T. Geer, Governor* –

MY DEAR SIR: Our Secretary, Mr. John Minto, having resigned his position, and the board having chosen me as his successor, it becomes necessary for me, under the law, to resign my position as commissioner, which I have held ever since the board was created some ten years ago. I accepted the position as secretary reluctantly, and only at the earnest solicitation of

the retiring secretary and my confreres, feeling the field of operation is much larger and I can be of more service to the fruit interests of our state as secretary than I possibly could as commissioner, with vastly increased labors, the compensation being very near the same for either position.

I therefore tender you herewith my resignation as commissioner for the first district, assuring you of my highest esteem.

Cordially yours,

HENRY E. DOSCH.

Which resignation was accepted, and Mr. Wilbur K. Newell, of Dilley, Washington County, was appointed my successor to fill the unexpired term.

The first bulletin was issued May 6, 1899, on

## CARING FOR ORCHARDS.

The season is at hand for the cultivation of, and caring for, our fruit trees this summer. The small crop likely to be gathered this fall, owing to the unseasonable climatic conditions, will have a tendency to cause many growers to neglect their trees when they need the utmost care and nursing. It is very human to do our utmost when everything is flourishing, and profits apparently large, to force matters; and equally human to drop everything when the reverse is the case. In several of the reports issued through the press, and leaflets by the United States Weather Bureau, it is stated that the unseasonable cold wave in February had done little or no damage. These reports are no doubt compiled from the statements received from local observers and correspondents throughout the state, and comming from such a source and high authority as the United States Weather Bureau, are presumed to be correct and reliable, and are very naturally believed by the fruitgrowers. Advices received at this office, however, from practical fruitgrowers and members of this board from the various districts, are of a different nature, and the damage done is becoming more and more apparent every day, especially in the middle Willamette Valley and parts of Eastern Oregon; the Umpqua and Rogue River valleys escaped without injury. We know now that thousands of young prune trees have been killed on lands not adapted to fruitraising, and thousands of others planted on more favorable land have been seriously injured, and, if neglected, many will either die or become permanently crippled, and such trees need our utmost care right now.

The continued cold rain, which makes the fruit drop, naturally tends to discouragement, and, in addition, neglect

of the orchard will invite fungous diseases and insect pests, and for these reasons alone the spray-pump must be kept going, regardless of any crop or no crop. We would, therefore, urge most earnestly upon owners of injured or fruitless trees not to become discouraged, but to give their trees extra care by pruning off injured limbs, spraying, and most thorough cultivation of the soil, for they need it much more right now than if in healthy condition. Good result is certain to follow by the fruit some of these trees may yet bear this year, being larger and finer, and by reason of this extra care such trees will start with renewed vigor and reward their owners for this additional work with an abundant crop the coming year.

Reverses are met with in all walks of life—the merchant, the banker, the artisan, and the grain farmer all share alike in off years, so to speak; why should the fruitgrower be exempt even in this most favored state of ours?

Oregon fruits are finding favor in many old markets, and with the new markets opening up to us the demand is certainly increasing, but this demand is only for first-class fruit, and such fruit cannot be grown on neglected and diseased trees. The up-to-date fruitgrower who will give his best thoughts, care and attention to his trees at such a time as the present, is sure to win, in the end, by abundant crops and remunerative prices; hence, we would say to all orchardists: Don't despair, don't get discouraged, but keep on right along as if we expected a most bountiful harvest, and good results are certain to follow.

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On June 23, 1899, we issued the following:

## FRUIT REPORT.

Agreeable with the work outlined when this board was reorganized last April, we sent out of this office and through the commissioners of this board in their respective districts, hundreds of letters of inquiry to prominent horticulturists in all the fruitgrowing districts, and from the replies received the following estimates are compiled. As so much misleading informationg about no injury to fruit trees and fruit has been published, we were very cautious in making these estimates, and, therefore consider them reliable on the dates they were made, May 15, but as the climatic condition since has been very unfavorable, a further discount on these estimates would not be out of order at this time:

FRUIT REPORT.

| *Districts.* | *Apples.* | *Pears.* | *Italian Prunes.* | *French Prunes.* | *Peaches.* | *Cherries.* |
|---|---|---|---|---|---|---|
| Junction | 60 | 10 | 20 | 10 | ------- | ------- |
| Jefferson | 60 | 30 | ------- | ------- | ------- | 50 |
| Scotts Mills | 90 | 50 | ------- | 60 | ------- | 60 |
| Silverton | 50 | ------- | 10 | 25 | ------- | 50 |
| Rosedale | 40 | 10 | 10 | 60 | ------- | 10 |
| Liberty | 25 | ------- | ------- | 40 | ------- | 75 |
| Zena | 30 | 50 | 10 | 20 | ------- | 50 |
| Independence | 40 | ------- | 10 | ------- | ------- | 50 |
| Corvallis | 40 | ------- | ------- | ------- | ------- | 50 |
| Dallas | 40 | 30 | ------- | ------- | ------- | 50 |
| Nashville | 60 | 40 | 10 | 20 | ------- | ------- |
| Eugene | 50 | ------- | ------- | 25 | ------- | 50 |
| Brownsville | 80 | ------- | 10 | 10 | ------- | ------- |
| Goshen | 75 | 10 | 10 | ------- | ------- | 60 |
| Albany | 50 | 25 | ------- | ------- | ------- | 60 |
| Hubbard | 40 | 10 | ------- | ------- | ------- | 25 |
| Salem | 30 | ------- | ------- | 25 | ------- | 25 |
| Dilley | 40 | ------- | ------- | 50 | ------- | 50 |
| Scappoose | 75 | 50 | 75 | 100 | ------- | 20 |
| Lafayette | 50 | 10 | ------- | 50 | ------- | 30 |
| Gaston | 60 | 40 | ------- | 40 | ------- | 30 |
| Carlton | 50 | 10 | ------- | 40 | ------- | 10 |
| North Yamhill | 60 | 40 | ------- | 10 | ------- | 10 |
| Newberg | 60 | ------- | ------- | 50 | ------- | 75 |
| Spring Brook | 50 | 30 | ------- | 50 | ------- | 25 |
| Mount Tabor | 50 | 25 | ------- | 30 | ------- | 50 |
| Russellville | 60 | 25 | ------- | 25 | ------- | 60 |
| Mosier | 50 | ------- | ------- | ------- | ------- | 75 |
| Mitchell | 80 | ------- | 40 | 100 | ------- | 100 |
| Clex | 100 | 100 | 100 | 100 | 30 | 100 |
| Hood River | 50 | 10 | 10 | 10 | 10 | ------- |
| Mount Hood | 80 | ------- | 50 | 50 | ------- | ------- |
| Dufur | 75 | 50 | 50 | ------- | ------- | ------- |
| Pine Creek | 75 | 75 | 75 | ------- | ------- | ------- |
| Blalock | 100 | 100 | 100 | 100 | 100 | 100 |
| Grants | 100 | 100 | 100 | i00 | 100 | 100 |
| The Dalles | 50 | 50 | 75 | ------- | 25 | 100 |
| Riddle | 50 | 100 | 10 | 100 | 100 | 80 |
| Canyonville | 75 | 10 | 10 | 100 | 100 | 80 |
| Grants Pass | 50 | ------- | ------- | 100 | 50 | 50 |
| Winston | 75 | 100 | 10 | 75 | ------- | 75 |
| Umpqua | 50 | 60 | 10 | 100 | 100 | 76 |
| Looking Glass | 50 | 60 | 10 | 100 | ------- | 2 |
| Oakland | 50 | 50 | ------- | 75 | ------- | 50 |
| Yoncalla | 50 | 35 | ------- | 50 | ------- | ------- |
| Roseburg | 60 | 75 | 25 | 75 | 75 | 75 |
| Woodville | 60 | 20 | ------- | 35 | ------- | 60 |
| Dillard | 100 | 75 | ------- | 75 | 75 | 100 |
| Days Creek | 100 | 100 | 25 | 100 | ------- | 75 |
| Medford | 75 | 60 | 25 | 80 | 75 | 60 |
| Langlois | 100 | 100 | 100 | 100 | 100 | 100 |
| Milton | 25 | 15 | ------- | ------- | ------- | ------- |
| Baker City | 75 | 75 | ------- | ------- | 60 | 75 |
| Union | 10 | 10 | 10 | 10 | 10 | 10 |
| Eagle Valley | 100 | 100 | 100 | 100 | 100 | 100 |
| Pine Valley | 100 | 100 | 100 | 100 | 100 | 100 |
| Ashland | 40 | 20 | 30 | 30 | 100 | 50 |

PROBABLE AVAILABLE QUANTITIES IN CARLOAD LOTS.

| County. | Fresh Apples. | Fresh Pears. | Fresh Peaches. | Evaporated Prunes. |
|---|---|---|---|---|
| Yamhill | 17 | 2 | | 14 |
| Washington | 1 | | | 3 |
| Multnomah | 2 | | | 4 |
| Clackamas | 5 | | | 6 |
| Columbia | 1 | | | 1 |
| Wasco | 15 | 3 | | 1 |
| Umatilla | 30 | 10 | 3 | 3 |
| Union | 25 | 5 | | |
| Baker | 5 | | | |
| Malheur | 2 | 1 | 1 | 2 |
| Marion | 5 | 1 | | 5 |
| Lincoln | 1 | | | 2 |
| Lane | 3 | 1 | | 3 |
| Benton | 2 | 2 | | 3 |
| Polk | 5 | 5 | | 3 |
| Josephine | 25 | 1 | 12 | 5 |
| Douglas | 15 | 5 | | 30 |
| Jackson | 100 | 45 | 100 | 25 |
| Coos and Curry | 3 | 1 | | 1 |

Berries of all kinds are reported a full crop from every section.

It will be observed by comparing the table of percentage of fruits of a normal crop with the table of the actual output, or amounts available in carload lots for commercial purposes, there is quite a difference, which is caused by the report from some section giving the highest percentages not being shipping points, and the observations are made from small orchards and holdings for home supply only, these orchards being mixed varieties, in most cases, and the failure of one or the other kinds are not being figured. This same table further shows in all districts given that there will be plenty of fruit for home consumption, and therefore the fruit crop cannot be considered a total loss, as has been reported. Many factors, however, enter into the total or partial failure of fruits this year in one or the other locality, which must be taken into consideration, and it is not altogether chargeable to the cold wave which passed all over the United States—from the Atlantic seaboard to the sunny shores of the Pacific—in February, damaging as it was to tree and fruits alike; nor to the unseasonable climatic condition which has existed since, such as orchards planted on lands not adapted to fruit culture, and in other instances, extra heavy crops borne by some varieties last summer, notably apples and pears, and consequent failure to set fruit buds for the year.

From the various reports received, other deductions are to be made; for instances, orchards with southern exposures;

and again, orchards on bottom lands show more damage to trees and fruits than on hillsides and higher plateaus, while orchards located well up on mountain sides are reported as having sustained no damage whatever to either tree or fruit.

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On July 23, 1899, the following report was issued on the

### WORLD'S YIELD OF FRUIT.

Some months ago this board entered into correspondence with the experiment stations, state boards of horticulture, horticultural societies, and principal fruitgrowers and dealers throughout the United States, as well as the American consuls in all the various fruitgrowing districts in China, Japan, England, France, Germany, Russia, Turkey, Austria, Hungary, Italy, Belgium, Sweden, and Holland, for the purpose of ascertaining the condition of the various fruits throughout the world, possible markets either at home or abroad, and what fruits and quantities our fruitgrowers would likely come into competition with.

We have received over six hundred replies from which the following tabular statements were compiled, and will prove valuable to the grower, the dealer, and shipper alike:

### APPLES.

Arkansas reported early in the season a good prospect for a full crop, but fruit has dropped badly since, and now they do not expect over fifty per cent. of a normal crop.

Connecticut, half crop.

Illinois, half crop.

Iowa, sixty per cent. of a normal crop.

Kansas, only thirty per cent., though prospects were very favorable early in the season.

Missouri looked for the largest crop ever had, now reports scarcely thirty per cent.

Michigan still reports sixty per cent. of a full crop.

Ohio also reports sixty per cent., but fruit small and of inferior quality.

Vermont, forty per cent.

These states represent the large apple-growing districts, showing Michigan in the lead.

California has two apple-growing districts, and reports fair prospects, with a probable shipment of one thousand cars.

Other states show as follows:

Colorado, fifty per cent. of a normal crop.

Idaho, sixty per cent. of a normal crop.

Indiana, fifty per cent. of a normal crop.

Kentucky, ten per cent. of a normal crop.

Maine, thirty-three per cent. of a normal crop.

Massachusetts, forty per cent. of a normal crop.

Montana, thirty-three per cent. of a normal crop.

Mississippi, ten per cent. of a normal crop.

Minnesota, forty per cent. of a normal crop.

New York, twenty-five per cent. of a normal crop, their main variety, Baldwins, being a total failure.

Nebraska, ten per cent. of a normal crop.

New Mexico, thirty-three per cent. of a normal crop.

New Jersey, fifty per cent. of a normal crop, being mainly summer and fall fruit; winter apples a failure.

New Hampshire, twenty-five per cent. of a normal crop.

North Carolina, fifty per cent. of a normal crop.

Oregon, fifty per cent. of a normal crop.

Oklahoma, fifty per cent. of a normal crop.

Pennsylvania, no fall apples, fair crop of winter apples.

Rhode Island, sixty per cent. of normal crop.

South Carolina, failure.

Tennessee, only raise summer apples, poor crop.

Texas, failure.

West Virginia, fifty per cent of a nominal crop.

Virginia, forty per cent. of a nominal crop. (This is the home of the Yellow Newtown Pippin; expect to ship one hundred thousand barrels).

Wisconsin, thirty per cent., but will have nothing to export.

Washington, fifty per cent. of a normal crop.

PEARS.

New Jersey reports seventy-five per cent. of a normal crop.

California, Florida, Maryland, and Minnesota, report fifty per cent. of a normal crop.

Georgia, Idaho, Missouri, North Carolina, Oklahoma, and Washington, twenty-five per cent. of a normal crop.

Louisiana, New York, Texas, Tennessee, West Virginia, and Virginia, ten per cent. of a normal crop.

Massachusetts and New Hampshire, forty per cent., but report poor quality.

Montana, thirty-three per cent.

Ohio, sixty per cent.

Oregon, thirty per cent.

Illinois, Iowa, Indiana, Kansas, Mississippi, Michigan, Maine, and Pennsylvania, report a total failure.

### PEACHES.

The principal peach-growing sections in the United States, report as follows:

California, full crop.

Colorado, half crop.

Florida, nearly a failure.

Georgia, total failure.

Idaho, twenty per cent. of a normal crop.

Maryland, total failure in the Blue Mountain ridge belt, and report twenty per cent. on tidewater lands.

Southern Oregon, very full crop.

Oklahoma, Texas, New Mexico, and Ohio, about twenty per cent. of normal crop.

Iowa, Indiana, Kentucky, Kansas, Louisiana, Maine, Missouri, Massachusetts, Montana, Mississippi, Michigan, New York, New Jersey, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, and the Virginias, all report a total failure.

### PRUNES.

California reports sixty-six per cent. of normal crop, ranging from twenty to eighty per cent. in different sections.

Idaho will have a half crop.

Oregon and Washington will not have over twenty-five per cent., these ranging from failure to one hundred per cent., according to locality, the highest percentage in Oregon being French prunes.

The picture is not a brilliant one, as far as fruit prospects are concerned. All of the reports state from a total failure of one or all of their crops to some sixty per cent. of some particular variety, which holds true throughout the world, except two bright spots in Oregon, one being Eagle Valley, Union County, in Eastern Oregon, and the other the Rogue River and Umpqua valleys in Southern Oregon, where all varieties of fruits, apples, pears, French and Italian prunes, peaches, grapes, French walnuts and almonds have a full crop, while other portions of Oregon share with the rest of the world.

The reports are a unit as to the cause of these failures. In

the United States the same unseasonable climatic conditions prevailed. The cold wave which rolled from the Atlantic seaboard to the shores of the Pacific in early February, followed by cold rains, destroyed in many states what promised earlier in the season to be a bountiful fruit harvest. Throughout Europe the most of the damage was done in April, continuing into June, and what the cold rains did not destroy was finally annihilated by many hailstorms.

While these conditions are very much to be regretted, and while we do not wish to rejoice over the misfortunes of others, yet it cannot help but be gratifying to the Oregon fruitgrower to know that we are not the only ones who have suffered. We have enough, yes, more than enough for home consumption of all kinds of fruits, and in some districts hundreds of carloads to ship to our less fortunate neighbors. This certainly will relieve the Oregon fruitgrowers from discouragement, and ought to be a stimulant for the future care of our orchards, especially so as the damage to trees reported from elsewhere is much more severe than here in Oregon. Permit me to quote a few extracts. Hon. Talbot J. Albert, Consul at Brunswick, Germany, says, among other very pertinent things: "The fruit crop is almost everywhere a failure." Hon. Frank H. Mason, Consul-General at Berlin, says: "The spring season was late, cold, and wet; heavy rains continued until after the first of June, and this, with the cold weather and a hailstorm which fell in this region about three weeks ago, has, according to all accounts, so damaged the young apples, pears, and plums that only an inferior crop will be realized." Mr. Cunningham, Consul at Chemnitz, a large manufacturing center, writes: "I wish I had time to detail the desires of the people here for our fruits. The fruit crop outlook here is bad; very, very bad. Weather was wicked all spring, is villainously cold now (May 29). Germans hunger for our fruits, apples before all others." And so are all other reports of foreign states, many stating that instead of exporting they would have to import more and more each season.

The demand for apples is very great in England and Germany, for our fresh products, and in France principally for what is known as "chops." Allow me to quote only one letter, which voices the contents of nearly all others. Mr. Joseph I. Brittain, Consul at Nantes, France, says: "There is a good opening for evaporated apples known as 'chops.' These apples are sliced thin and dried, including skins, seeds,

and cores; they are packed in plain barrels. The poorer classes here use large quantities of these apples for making cider. Last season one firm sold more than twelve thousand barrels, and they sell at present for seven cents per pound. Prunes sell at sixteen to twenty cents," etc.

A few days ago a letter of inquiry came from Bordeaux, France, to this office, in regard to evaporated prunes, showing that there is not only an increasing market for our goods, but also that Oregon fruits are becoming favorably known, and that the trade is reaching out to us for them, which certainly is very gratifying. Several noticeable facts are to be emphasized, however. One is that all consuls say there is a good market for our fruits, and place the apple, either fresh or evaporated, first on the list, which endorses my statement in my January report that the apple is the commercial fruit of the world today, with the evaporated prune as a good second; the other is the attention called to the packing of all fruits by all correspondents, saying that only goods packed honestly and in a merchantable manner will command high figures, and evaporated goods should be packed in small, neat boxes.

In conclusion, we beg to say that the outlook, present and prospective, for Oregon fruits, is most encouraging, which will increase with developing markets abroad, notably the Orient. While prices rule high this season, we cannot reasonably expect them always, but may feel confident that generally they will be remunerative to the progressive horticulturist.

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## GOOD MARKET FOR FRUIT.

*To the President and Officers of the Oregon State Board of Horticulture, Greeting:*

I have the honor to present to you herewith my report of the doings and proceedings of this office since our meeting at Salem in April.

Agreeable with your instructions, this office was removed from the State Capitol at Salem and located in the Assembly Hall of the Chamber of Commerce, this city, Mr. J. L. Hartman kindly furnishing us the room and space required for our exhibits free of charge. The location is a fairly good one, for the reason that all persons arriving in our state, either seeking farm or orchard lands, or for the purpose of making investments in either mines, manufacturing, or other

business pursuits, naturally seek the Chamber of Commerce as the supposed center of unbiased information. This surmise proved to be a correct one, as hundreds of people called for information of every kind, which was given to the best of my ability. It is particularly gratify to state that a great many horticulturists of our own state called while in the city for enlightenment on many subjects in which they were deeply interested.

### COMMERCIAL INFORMATION.

For a number of years I have been convinced that this board should enlarge its scope of usefulness by reaching out to seek reliable information regarding the fruit crops in other states likely to come into competition with our own fruits in the world's markets, as well as to seek new fields for our own choice fruits. With this object in view I entered into correspondence with the experiment stations, state boards of horticulture, horticultural societies, and the principal fruitgrowers and dealers throughout the United States, as well as the American consuls in all the various fruitgrowing districts in Germany, France, England, Russia, Austria, Hungary, Turkey, Italy, Belgium, Sweden, Holland, Chinese Empire, and Japan. We have received over six hundred replies, the results of which have been published in the *Oregonian* and the horticultural press, from time to time, for the benefit of our fruitgrowers, the summary of which is, however, that the fruit crop throughout the world this year was exceedingly small, and in most cases inferior in quality, owing to unseasonable climatic conditions, notably in Europe, where hailstorms in July destroyed almost completely what little fruit the frosts and cold rains left on the trees. As expected, many letters came from dealers in response to the statement published by this board of a large crop of fruit in certain sections of our state, all of which were answered, and dealers and growers brought into direct communication with each other.

I have taken great pains to impress upon our fruitgrowers these facts, and stated that in consequence of these conditions good fruit would bring high prices, and to hold out for them, so that they would reap the benefits sought to be bestowed by the inquiries made by this board. This work has no doubt been appreciated, for many of our progressive orchardists who have called were pleased with the results of the voluntary work done by this board.

## SCARCITY OF FINE FRUITS.

The last *Fruit Trade Journal*, of New York, says: "The exact situation regarding the apple crop is still a question of doubt; even those who are well informed on this subject express themselves as being at a loss in judging conditions this season. While there is undoubtedly a large crop, its quality seems to be constantly deteriorating. Adverse reports are still being received from all sections. The fruit is dropping badly, and where picking is in progress, the yield appears to be lighter than anticipated, and the quality somewhat inferior. *Fruit Trade Journal* has believed that earlier estimates were far in excess of the probable yield, and its reports have been more or less to that effect, which present information tends to confirm."

It will be seen that while there will be plenty of apples of ordinary quality, there will be no surplus of fine fruit. Pears sold at auction in Chicago realized, for Doyenne du Comice, $2.85; Bartlett, $2.50; Beurre Clairgeau, $1.85; and Winter Nellis, eighty-five cents per box. Prunes: Italian, $1.25; Petites, $1.65; and Silvers, $1.60 per crate, which certainly are most satisfactory figures. It will be observed that the Doyenne du Comice brought the highest figures, and they generally do. This pear does not receive the attention it should, as it is unquestionably the finest pear grown today; the tree being a healthy, vigorous, upright grower.

Notwithstanding the "bearing" of the market on the part of evaporated prune dealers, there seems absolutely nothing to warrant it. We know that Europe will have to import, instead of exporting, as heretofore, and that the Eastern markets are depleted; hence the figures offered seem very low.

## ORIENTAL MARKET.

When I stated a year or more ago that we should reach out for this market, the advisability was called into question, but that there is a market there for fruits is evidenced by the fact that importations of fruit have been made in 1898, towit: British East Indies, $12,346; British Australasia, $260,611; other Asiatic possessions and Oceanica, $147,151; Hong Kong, $67,718; rest of China, $23,761; Japan, $22,713. Here are markets which should be cultivated and developed, and are practically our own, especially for our fine apples and Italian prunes. The evaporated product of this prune is too

fine to bring into competition with sun-dried French prunes, as is done now in our Eastern markets, which competition would be eliminated in the Orient, as the inhabitants of that climate demand a semi-tart fruit, a quality not possessed by the sweet, insipid, sun-dried French prune of California. Therefore this market belongs exclusively to the Pacific Northwest, and these people should not be compelled to send to Europe to supply the increasing demand. But, in order to compete with European fruits, we must prepare our goods as these markets demand it. Hon. A. Burlingame Johnson, Consul at Amoy, covers this ground completely in his report to our government, based upon the inquiry made by this board. Permit me to quote: "There is a steadily increasing demand among the natives for foreign fruits, whether canned, dried, or preserved. The European population look to these imported fruits almost exclusively to supply their tables. Tinned pears, peaches, and apricots, come principally from America, while preserved fruits, jams, and dried fruits still come largely from Europe. The reason is apparent. The American manufacturer will not, or does not, meet the conditions required. Since there are no peaches or pears in Europe which can compete with those of California, the Oriental merchant has no choice; in other lines he is not so restricted. Prunes and raisins are largely used. The dried fruit is put up in bottles and sealed. In no other way can it be shipped to the tropics without great loss, as the humidity of the climate, or insects, will soon render it unsalable. No fruit, biscuits, crackers, or any other food product can be safely shipped to central or southern China, or the Philippines, without being sealed in glass bottles or tinned. The English and Continental merchants and manufacturers understand this, and put up their fruits accordingly. If tinned, the tins are either painted or varnished to prevent rust and consequent loss to merchants.

The American manufacturer has found a market for his product without these extra expenses, and is slow to meet the demand; hence dried fruit, jams, and tinned fruits are usually bought in other countries where these necessary details are looked after. If our exporters of fruit expect to hold the market in the Philippines, or to gain a better footing in China, they should begin by studying the conditions, and promptly meeting them. Prices realized in China for fruits justify the expense necessary to put them up so as to insure their being in good condition when they reach the consumer."

This is a decidedly plain statement of the conditions, and we should not fail to grasp the situation. Lord Beaconsfield said: "The great secret of success in life is to be ready when the opportunity comes."

### FRUIT INSPECTION.

In order to carry out the amended law regarding the sale and shipment of diseased or infected fruits, I, as quarantine officer of this port, informed all dealers in this city that the law would be enforced, gave them copies of said law, and requested them to notify their customers to that effect, in which they co-operated heartily. Since the beginning of the shipping season I have examined fruits arriving on Front Street daily, and am pleased to state that I was forced to condemn only one lot, consisting of twenty-four crates of Italian prunes infected with San Jose scale. Owing to some fruits being condemned at places in other states which our shippers considered unjust, I offered to examine fruits prior to shipment, free of charge, and issue a certificate to that effect. Those who have availed themselves of this offer report having had no trouble since.

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### FRUIT IN EASTERN OREGON.

Compliant to numerous requests to visit the Eastern Oregon fruit section, President H. B. Miller, Commissioner W. K. Newell and myself made the journey and extended our investigations into the Snake River region, both Oregon and Idaho sides. The primary reason for going as far as the Boise Valley was to look into the economic aspect of horticulture under entirely different soil and climatic conditions from those prevailing in the Willamette Valley.

The Snake River region, extending from Huntington to Mountain Home, a distance of some one hundred and fifty miles, belongs to the arid region, with a light soil, and heretofore was considered worthless, but under irrigation it has blossomed out most wonderfully. Some seventeen thousand acres have been planted in fruit of various kinds, and up to now the trees have made good growth and produced good crops. We have found that in this entire region the top soil is underlaid with a strata of hardpan, impervious to water or roots. This top soil varies from six inches to eight feet in

depth, and the thickness of this strata of hardpan is from three inches to fifteen inches. Underneath this hardpan is gravelly loam, rich in plant food, but not available at present on account of this hardpan. Had the orchardists of that region examined into this soil condition, and adopted the advice given by this board for years past, by dynamiting the soil, thus shattering the hardpan and allowing roots and water to go down, they would not now be confronted with the problem they are. The trees planted on this light, shallow topsoil have about used up all the available plant-food, and in consequence stopped growing and soon will cease to bear fruit—the roots have spread out on the surface, and are therefore liable to injury from freezing, and the trees become loose and easily thrown over by strong winds. The only remedy now is to bore a hole into the hardpan between the rows of trees, and dynamite it, which will materially assist the feeding root to go down and prolong the life of these trees. However, all this should have been done prior to planting.

We are also of the opinion that if the soil is properly dynamited irrigation will be more perfect, as the water will go down easier, and in consequence will require less irrigation and more cultivation, and bring up the water from below by capillary attraction. That this theory is correct is evidenced by the fact that wherever it has been tried it has proven successful. Mr. J. S. D. Mannville, of Boise, dynamited his soil with good effect. Mr. David Dunbar, near Vale, Malheur County, planted an orchard, but it did not do well—the trees grew slowly and were continually blown over. After five years of experimenting, his hired man, who had read our reports, suggested dynamiting, which they did, and planted an orchard alongside the old one, and now these later trees are three times the size of the old ones, are strong, healthy, and bear abundant crops of fruit. In view of such conclusive object lessons, it seems to us that intelligent, progressive horticulturists would not be slow in adopting the methods suggested.

One of the most remarkable observations is that trees in the Grande Ronde, Powder River, Burnt River, Malheur River, Weiser, Payette, Boise, and Snake River valleys go into bearing at such an early age, and attain such large size. Orchards at four years bear good crops of fruit, and the trees are fully as large as six and seven-year-old trees in the Willamette Valley, which can only be explained by the large quantity of available phosphoric acid, potash and nitrogen in this soil, which, how-

ever, is exhausted at ten years, as explained above, and new feeding ground must be provided by breaking up the underlying hardpan.

Mr. Richardson has an apple orchard of thirty-five acres near La Grande, now four years old, which yielded six hundred boxes of most excellent fruit this year, which is considered an off year on all kinds of fruit.

### IRRIGATION.

The entire Snake River district, both Oregon and Idaho sides, is susceptible to irrigation by the waters from Snake River itself, but more easily obtained from Malheur, Owyhee, Boise, Payette, and Weiser rivers, several large canals being now in use for the orchards and alfalfa fields planted under their lines. Irrigation, however, does not seem to be thoroughly understood, for we found nearly all the feeding roots to be close to the surface, which would indicate too much irrigation on the one hand and not cultivation enough on the other, and we reached the conclusion that if the hardpan were thoroughly dynamited to allow the water to percolate through, much less irrigation would be necessary, and by thorough and frequent cultivation the roots would be forced down, making healthier, stronger, longer-lived trees, and less susceptible to disease.

### FRUITS TO GROW.

Owing to the entire absence of apple scab and pear blight, which is, no doubt, due to the lighter, drier atmosphere, we are of the opinion that the growing of winter apples, and especially winter pears, would be most profitable, as the latter can be grown only with difficulty west of the Cascade Mountains. The demand for winter fruits is very large and increasing, and the soils of the Eastern Oregon valleys and Snake River region seem specially adapted for apples and pear culture. It is essential, however, to select such varieties as mature late, say the last of October or early in November, for fruits which mature during the hot weather will not keep, as the fruit juices are warm when the fruit is picked, and will ferment and soon decay; but such fruits as ripen when the cool season has set in will keep well, and have excellent shipping qualities. We would particularly recommend the planting of such varieties as will stand ocean transportation, to supply the ever-increasing demand for our fine apples and

Grand Boulevard, two miles long. Apple orchard of Kiesel, Schilling and Donelson near Ontario, Eastern Oregon.

pears in the markets of England, Germany and France, and from now on the rapidly developing Oriental trade. In the foothills, however, especially about Cove, in the Grande Ronde Valley, we find the seasons very short, hence such varieties should be selected which come to maturity rapidly, in order to make it profitable.

Another fruit adapted for that region is the Italian prune. The trees now in bearing seem strong and healthy, and the fact of their ripening late in the season, in fact, after all prunes of Western Oregon and California have long been consumed, give them a special market value as a fresh fruit. The Italian prunes which were sent to us at the Trans-Mississippi Exposition, at Omaha, last year in October, from Ontario and Payette, were the finest on exhibtion. Owing to their lateness they will always command high prices. French Prunes do not do well there. Owing to the cheapness with which ice can be procured along the Snake River for cold storage, they possess a great advantage over other sections, and fresh fruits can be kept to humor the market, and fruitgrowers of that section would do well to consider this point. Very few prunes are being evaporated in this section. The facilities for it are limited, but will develop, no doubt, as occasion demands. In the Grande Ronde Valley prunes, and especially cherries, mature even later than in the Snake River country, and at a time when such fruits are sought after, and would, therefore, make a most profitable crop to grow.

## VARIETIES.

The choice for apples so far planted is: Ben Davis, Wolf River, Jonathan, Golden Reinette, Gano, Rome Beauty, York Imperial, and Shakelford. In pears we would suggest: Winter Nellis, Beurre Easter, Fall Butter, Beurre d'Anjou, and Doyenne du Comice—all excellent fruits, good keepers, and commanding the highest market prices.

In the K. S. & D. two-hundred-acre orchard, near Ontario, we were shown a number of apple trees, all of one variety, the young growth of which was severely injured by last February's freeze, which checked its growth completely, though not all in one place, and not touching other varieties alongside, and as this is the second time it occurred, it would be well to watch them closely, and possibly remove them for others, as they would not be profitable to grow.

Speaking of frosts, we learned that it is impossible to locate any spot exempt from it, but all orchards are not always injured, as the blooming varies materially even in orchards close to each other. Frosts, however, seldom do any damage, except during pollination; after the fruit has set it will stand quite a freeze. Mr. McPherson, Horticultural Commissioner for Idaho, tells us that often in spring fruit and leaves are frozen stiff, but for some unknown reason they generally thaw out without injury.

### INSECTS AND DISEASES.

Of insects there are the San Jose scale, green aphis, and red spider, which, however, are easily controlled now by applying remedies given by our bulletin and reports; but by far the greatest enemy is the codling moth, of which they have some three and one-half broods per season, owing, no doubt, to the warm nights which prevail during the season. The band system is used extensively, and spraying followed religiously, but the best results have only been obtained by those who persistently watched and examined the band every week, as the larvæ develops in about that period, and sprayed almost continuously—many growers going over their orchards twice and three times in succession when the apple has attained the size of a hazelnut and before the calyx closes, so as to fill this place full of poison for any codling moth larvæ which may find its way there, the usual point of attack, many orchardists going so far as to pick off all wormy fruit.

We further found that along the foothills of the Grande Ronde Valley, notably near Cove, the codling moth has not obtained foothold, very few apples there being wormy. This is no doubt attributable to the cool nights prevailing there the year round. As regards the development of the moth, there is a vast difference between the Grande Ronde and the Snake River districts. The codling moths are more severe in the Boise River Valley and its tributaries than any part of the fruitgrowing district of the Northwest. In the Grande Ronde Valley, however, the injuries from it are as light as anywhere, except directly on the coast line, where the moth does not propagate at all, which is evidently due to climatic conditions.

As stated before, we have been unable to find any apple scab or pear blight, or even the dreaded apple canker or deadspot, but have found the crater blight of the pear quite serious, and unless taken in hand at once and stamped out it

will prove very disastrous to existing pear orchards and those being planted.

In conclusion we would state that the adaptability of the soil and cheapness of alfalfa-growing would make that country an ideal creamery field, and by way of diversified farming, with the additions to horticulture, or growing hogs, cattle and sheep, make it a great field of operation and promise.

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Early in January, 1900, it was deemed necessary to inform growers and dealers as to the enforcement of the new law, so all might govern themselves accordingly, and the following bulletin was issued :

" *To the Public:*

"Agreeable with the conclusions arrived at by this board at its last fall meeting, all the commissioners of the various districts have been very active in fieldwork, inspecting orchards, nurseries, home places, etc., and hundreds of notices have been served to clean up neglected places in accordance with the horticultural law governing such cases, and for their benefit and guidance these sections are herewith given in full. We also give the sections covering the sale of diseased fruits, so that shippers and dealers may govern themselves thereby :

" Section 2. It shall hereafter be the duty of any person, firm, or corporation, owning or operating any nursery, fruit orchard, hop yard, flower garden, or ornamental trees, and knowing such to be affected with any kind of insects, pests, disease, to immediately spray or destroy the same in such manner as the fruit commissioner for his district may direct.

" Section 5. It shall be unlawful for any person, firm. or corporation to import or sell any infested or diseased fruit of any kind in the State of Oregon.

" Section 8. It shall be the duty of the Commissioner of the State Board of Horticulture of the district in which a violation of this act occurs to present the evidence of the case to the district attorney, whose duty it shall be to prosecute any person guilty of a violation of this act ; which prosecution may be brought in any of the justice courts of this state.

"We call special attention of growers and shippers to section 5, and notice is hereby given that diseased, scabby, wormy or scaly fruit will not be allowed to be sold in any of the markets of this state hereafter. While the board hopes that

it will not be necessary to use harsh measures, it must be fully understood that in case of noncompliance the law will be strictly enforced."

This notice proved timely and beneficial, as jobbers in this city expressed a willigness to co-operate and handle nothing but clean fruit. These facts were published far and wide, and many a spray-pump which otherwise would have remained idle was called into requisition with most gratifying results. Never since the early days of Oregon horticulture were apples cleaner, freer from fungous diseases and worms, and in consequence found more buyers at higher prices.

At this time it became apparent that our office was not located to be very convenient for those who wished to visit it, and for the display of our horticultural products. As there were no funds for the renting of a suitable room or office, I conceived the idea of enlarging our sphere of usefulness by starting a permanent exhibit of Oregon products and information bureau concerning Oregon industries. Knowing that this would cost about $2,000, and in order to enlist the assistance of transportation companies and merchants of Portland generally, I laid the matter before the Chamber of Commerce for co-operation. The idea was received very favorably, and they appointed a committee to assist me in raising the necessary funds to carry out the project. After a good deal of hard work we succeeded in raising $2,000—$1,200 for rent, $480 for janitor, $300 for fixtures. I had agreed to give my services and personal supervision for one year free of charge, and early in April moved our office and exhibits to the large storeroom, No. 246 Washington Street, where I have since maintained a complete exhibit of Oregon resources in horticulture, agriculture, mines, forestry, dairy, fish, and stock. This has been of great benefit, not alone to visitors from abroad who come here to see what the state produces, either for settlement or investment, but to our fruitgrowers in particular. Here they can see all the various fruits grown on different soils and under different climatic conditions, thus being enabled to compare the fruits of the various sections, and it is therefore a great educator. I am pleased to say that our fruitgrowers see the advantage of the opportunity offered, and make free use of our office and exhibit.

Our semi-annual meeting was held at this room April 9, A. C. This was a notable meeting. The morning session opened with a general discussion on the efficiency of spraying

fruit trees for the extermination of codling moth. Most satisfactory results, it was shown, were produced, where the spray was properly prepared and the spraying persisted in. Olwell Brothers, of Central Point, who have one hundred and sixty acres of apple trees, sprayed systematically five times during the season, and have secured ninety-eight per cent. of clean fruit thereby and two per cent. only containing worms. They sold $14,000 worth of apples last year.

E. L. Smith and H. C. Sayres, of Hood River, reported as the result of thorough spraying the securing of ninety-five per cent. of clean fruit, with only five per cent. showing worms.

LaSalle Brothers, of Albany, who have fifty acres of apple trees, by persistent spraying, saved ninety-six per cent. of their fruit. Many others reported equally satisfactory results from following this plan. All these fruitgrowers have used the particular sprays recommended by this board, and, in view of such testimony, the conclusion was reached that the contention, "That spraying is inefficient," is fallacious, as well as absurd.

The retiring President, Hon. H. B. Miller, who resigned his position to accept the appointment as United States Consul to Chiang Kiang, China, read his report, which will be found elsewhere in this volume, after which he introduced his successor, Hon. E. L. Smith, of Hood River. In this connection the following resolutions were adopted:

WHEREAS, Hon. H. B. Miller, the President of the State Board of Horticulture, has voluntary resigned the commissionership-at-large, in order to accept a foreign consulship;

*Resolved*, That it is the sense of the members of the State Board of Horticulture that it is with regret that they see President Miller sever his relations with the board, and, as members of the board, would regard his loss to the horticultural interests of the state irreparable, were it not that he is succeeded by such a well-known horticulturist and energetic gentleman as the Hon. E. L. Smith of Hood River.

*Resolved*, That the good will and wishes of the members of the board will go with President Miller on his foreign mission, and that we believe he will use great energy in the Orient in securing the introduction of Oregon fruits in that section of the world.

Many letters were received at this time regarding the enforcement of the quarantine law. Growers and dealers seemed alike anxious, and it was decided that inasmuch as there would be a full crop of fruits, the law should be strictly enforced, whereupon the following letter was issued, inclosing a copy of the law, towit:

*To Dealers in Fruit—*

DEAR SIR: We beg to hand you appended a copy of the law governing the sale or shipment of diseased fruits. This law will be strictly enforced, and no diseased or infested fruits will be allowed sold in this market. We hope you will govern yourself accordingly.

Copies of this letter were mailed to the retail dealers in all the cities of this state, with most gratifying results. I have personally inspected the wholesale districts of Portland daily, and as many of the grocery and fruit stores as I could; but very few dealers had to be reminded of the law, and, in consequence, the fruit offered for sale was exceptionally free from disease and worms, so much so, that it created considerable comment on the part of the consumers.

## FRUIT CROP OF OREGON.

Continuing the work outlined by this board a year ago, our commissioners have again made an estimate of the present fruit crop throughout Oregon, based on personal examination of the orchards, as well as upon many replies to inquiries sent from this office early this month.

The work done by the board along this line a year ago has been much appreciated and proved very beneficial to our growers, as it drew the attention of dealers and eastern shippers to the various sections having a surplus for export, which otherwise would not have done so. This is evidenced by the number of letters reaching this office making inquiry as to the probable available quantity of the various fruits for eastern markets this year.

For the benefit of our own growers and exporters I have written to all the consuls in the fruit-consuming districts of the world, as to the condition and prospects of the fruit yield, and as soon as the replies are received, will tabulate them for publication. A similar report from all the fruitgrowing sections of the United States is now being compiled, and will be published later.

### ESTIMATED FRUIT YIELD.

Morrow, Wasco, Gilliam, Crook, Wheeler, Grant, and Sherman counties:

| | Per cent. |
|---|---|
| Apples | 95 |
| Pears | 75 |
| Fellenberg (Italian) prunes | 80 |
| French prunes | 90 |
| Cherries | 70 |
| Peaches | 75 |

Union, Umatilla, Baker, Malheur, and Wallowa counties:

| | Per cent. |
|---|---|
| Apples | 100 |
| Pears | 95 |
| Fellenberg (Italian) prunes | 100 |
| Cherries | 90 |
| Peaches | 95 |
| Apricots | 95 |

Douglas, Josephine, and Jackson counties:

| | Per cent. |
|---|---|
| Apples | 80 |
| Pears | 20 |
| Fellenberg (Italian) prunes | 10 |
| French prunes | 50 |
| Peaches | 10 |
| Grapes | 75 |

Coos and Curry counties, full crop of all kinds of fruits.

Multnomah, Clackamas, Yamhill, Washington, Columbia, Clatsop, and Tillamook counties:

| | Per cent. |
|---|---|
| Apples | 100 |
| Pears | 95 |
| Fellenberg (Italian) prunes | 30 |
| French prunes | 100 |
| Cherries | 65 |
| Grapes | 65 |

Lincoln, Marion, Polk, Benton, Linn, and Lane counties:

| | Per cent. |
|---|---|
| Apples | 80 |
| Pears | 90 |
| Fellenberg (Italian) prunes | 30 |
| French prunes | 100 |
| Cherries | 65 |

All percentages being based on a full crop of one hundred per cent.

Berries of all kinds are reported a full crop in every section, and never in the history of Oregon were wild strawberries and blackberries larger, finer flavored, or more abundant than the present year.

From these reports it will be seen that Eastern Oregon will have the largest fruit yield ever harvested in that section, and the apple crop will be especially large all over the state. The peaches in Southern Oregon, and the Fellenberg prunes throughout the Willamette Valley are the only fruits which have been injured primarily by frosts. This means a loss of about ninety carloads of peaches to Southern Oregon, and possibly four hundred carloads of Fellenberg prunes to the Willamette Valley.

There has been much speculation as to the partial failure

of the Fellenberg prune, and many theories have been advanced, but there is no question but that frosts gave the finishing stroke, while many other factors enter into the question, such as weak pollination, cold rains, check of sap flow, starvation, etc. Primarily it must be remembered that the Fellenberg prune is a weak pollinator under the most favorable conditions. Pollen is very sensitive to climatic changes, and if injured or weakened by cold rains, as was the case this year, it makes a feeble offspring, easily destroyed. Had warm and pleasant weather followed these cold rains, there is no doubt that many orchards would have pulled through with a fair crop of prunes, but the severe frosts which followed were too much for the embryo prunes in their weakened condition, and they dropped off, which could have been prevented by smudge fires. However, I do not wish to enter into this controversy at this time, as it has been thoroughly and conclusively proven a correct method of preventing injury to fruits, grains, and vegetables from frosts, and it is too lengthy a subject for a report of this kind. Those who are interested and desire to inform themselves more fully on this subject are referred to page 451 of our last bienniel report, Farmer Bulletin No. 104, Weather Bureau Bulletins Nos. 186 and 219, United States Department of Agriculture, and to growers in our state who have saved their fruits by smudge fires. (See article on frost in this report.) These reports are far-reaching, not only for fruit people, but, being copied in hundreds of eastern papers, act as an immigration literature.

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## FRUIT CROP OF UNITED STATES.

Last year I sent out letters of inquiry as to the probable output of fruit in the various fruitgrowing sections of the United States for the benefit of our growers and dealers. The replies received and published proved of great benefit, and were so much appreciated that I have this year again mailed some three hundred letters of inquiry to the officers of horticultural societies, state boards of horticulture, principal fruitgrowers, and dealers. Two hundred and seventeen replies have been received up to date, from which the following tabulated statement was compiled, and I hope it will again prove valuable to the grower, the dealer, and shipper alike. The percentages given are based on a full crop of one hundred per cent.

FRUIT CROP OF UNITED STATES.

| State. | Apples. | Pears. | Plums. | Peaches. | Cherries. | Grapes. | Italian prunes. | French prunes. |
|---|---|---|---|---|---|---|---|---|
| Arkansas | 50 | | 10 | 25 | 25 | 95 | | |
| Connecticut | 70 | 90 | 75 | 95 | | 100 | | |
| California | 50 | 50 | 60 | 80 | 70 | 90 | | 80 |
| Georgia | 75 | 80 | 75 | | | 100 | | |
| Illinois | 60 | 40 | 90 | 100 | 40 | 75 | | |
| Idaho | 100 | 100 | 100 | 100 | 75 | 100 | 100 | |
| Indiana | 35 | 30 | 30 | 15 | 90 | 100 | | |
| Iowa | 75 | 20 | 70 | 50 | 60 | 40 | | |
| Kansas | 50 | 10 | 50 | 60 | 40 | 100 | | |
| Maine | 90 | 80 | | | | | | |
| Maryland | 25 | 50 | | 100 | | 75 | | |
| Michigan | 90 | 80 | 75 | 90 | 40 | 100 | | |
| Minnesota | 100 | 20 | 50 | | | 70 | | |
| Missouri | 40 | 30 | | 25 | 60 | 80 | | |
| Montana | 80 | | 70 | | | | | |
| New Hampshire | 50 | 40 | 25 | | | 80 | | |
| New Jersey | 80 | 60 | 100 | 100 | 50 | 100 | | |
| New York | 85 | 40 | 60 | 100 | | 100 | | |
| North Carolina | 85 | 65 | 80 | 90 | 70 | 90 | | |
| Ohio | 65 | 40 | 50 | | | | | |
| Oregon— | | | | | | | | |
| Southern | 80 | 20 | 70 | 10 | | 100 | 10 | 50 |
| Western | 90 | 80 | 100 | 10 | 65 | 75 | 30 | 100 |
| Eastern | 100 | 95 | 100 | 95 | 90 | 100 | 100 | |
| Pennsylvania | 60 | 50 | 65 | | | | | |
| South Dakota | 50 | 50 | 30 | | 90 | 60 | | |
| Virginia | 30 | | 90 | 100 | 95 | 100 | | |
| Washington— | | | | | | | | |
| Western | 60 | 50 | 70 | | 30 | | 25 | 50 |
| Eastern | 80 | 75 | 90 | 90 | 70 | 100 | 85 | |
| Wisconsin | 60 | 40 | 35 | | | | | |

Nova Scotia, Ontario and Canada report a full crop, especially of winter apples, and, as these districts are great factors in the export trade, they must be taken into consideration.

In looking over the list one cannot help noticing the immense fruit crop to be harvested throughout the United States, and it will be further noticed that, like a year ago, Oregon stands at the head. One fact is very much emphasized and dwelt upon by my correspondent, and that is the dropping of apples in many districts, but they say it is only in neglected orchards. Those orchards which have been systematically sprayed and thoroughly cultivated hold their fruits, are clean, well-shaped and free from scab or worms—which can also be said of our own commercial orchards as well as many smaller places — all progressive fruitgrowers having learned this lesson long ago.

Unlike a year ago, we are confronted with an immense apple crop for export, and if we desire to obtain the highest, or even remunerative prices this year, only choice, clean fruit should be selected, carefully wrapped and packed in four-tier boxes, especially such as are destined for England, France and Germany. To illustrate, permit me to state that early

last March a car of four-tier apples were shipped by a Portland house to Hamburg, Germany, which came from a commercial orchard in Southern Oregon. These apples sold for fifteen marks ( $3.65 ), notwithstanding that plenty of five-tier apples were in that market at the time, and netted the growers $2.45 per box after paying freights, commissions and all other expenses. The reasons for such fancy figures were simply absolutely clean fruit, honestly packed and labeled, all apples being of the same size and quality. I have repeatedly stated that to do otherwise is commercial suicide, and sincerely hope that our growers, dealers and shippers will follow the example set by our Southern Oregon friends, and will not make a fatal mistake in this year of plenty.

This brings us back to the old question of competition in European markets, and the more the question is studied the more I become convinced that the Orient is the market for us to develop. The Oriental market is practically our own, and, when we realize this, and turn our attention to it, we will sever the Gordian knot of competition with one clean cut.

## FRUIT CROP OF EUROPE.

Agreeable to my statement in the report of the expected and estimated fruit yield throughout the United States made a month ago, I now present the fruit prospect of foreign countries, based on several hundred replies received to a letter of inquiry sent out by me to United States consuls and dealers immediately in touch with importation of fruits from America to their respective countries, being percentages based on a full crop of one hundred per cent:

| | *Apples.* | *Pears.* | *Prunes.* |
|---|---|---|---|
| England | 100 | 90 | 50 |
| France | 100 | 85 | 100 |
| Belgium | 75 | 60 | 100 |
| Russia | 100 | 40 | 30 |
| Holland | 90 | 70 | 100 |
| Servia | 80 | 80 | 100 |
| Bosnia | 80 | 75 | 100 |
| Switzerland | 95 | 80 | 100 |
| Hungary | 90 | 60 | 100 |
| Italy | 50 | 40 | 50 |
| Poland | 100 | 80 | 100 |
| Austria | 100 | 90 | 100 |
| Prussia | 55 | 40 | 60 |
| Bavaria | 60 | 40 | 90 |
| Wurtenberg | 90 | 85 | 90 |
| Hessen-Darmstadt | 100 | 90 | 100 |
| Turkey | 70 | 40 | 100 |
| Sweden and Norway | 80 | 30 | -------- |

China and Japan are not reported as they are principally consumers.

It will be noticed that, like the United States and Canada, nearly all Europe expects to harvest a bountiful crop of fruits, and, as Consul Adolf L. Frankenthal, of Berne, aptly remarks, "This is what is called a fruit year." But, unlike ourselves, they seldom produce enough for home consumption, except prunes, leaving still a fine field for exportation of our fine apples and Fellenberg (Italian) prunes. The most noticeable fact in looking over the estimated percentage is the large yield of prunes, notably the French prunes in the districts of the valley of the Loire, and the small prunes of Turkey, Servia and Bosnia, though inferior in every respect to the Pacific Coast grown prunes, are nevertheless a factor in keeping down prices, especially for sizes running from eighty to one hundred and twenty to the pound.

The consuls report to me at great length, and some of the suggestions are of so much value that I trust you will kindly allow me to quote:

Mr. Hugo Henzelman, of Prague, says: "If only you could find a way by which your fruit could be gotten into this market here, referring especially now to fresh fruit, you would be surprised at the quantity that could be sold here, for it is a fact not to be disputed that the people here, both rich and poor, are really wanting our fruits, the rich because it has a finer flavor and excels the home fruit here in every way, and the poor because they could buy our fruit cheaper here than the fruit grown here."

Mr. Talbot J. Albert, Consul at Brunswick, says: "Each year the demand for our fresh and dried fruit increases in Germany. This is ascribed to the improved condition of the working population, which now enjoys the consumption of fruits more than formerly."

Consul-General Frank H. Mason writes from Berlin: "From all the sources, and from a special report just made, I learn that the outlook in Prussia is meager for apples, pears, and prunes (see percentage table). The spring was very late, dry and cold, late frosts injured the blossoms in many districts; then came profuse and continuous rains, which have greatly injured all fruits. There will be an eager and abundant market for American dried fruits in Germany this year."

The Consul at Bordeaux, France, Mr. Albion W. Tourgee, who writes at great length, makes some very good points.

He says in part: "The season has been unusually favorable to most kinds of fruits, having no late frosts, a dry time at blossoming, frequent and abundant rains afterwards. Apples in the south of France are never good, but the pear crop promises well—to be exceedingly large, and will certainly be of fine flavor. The pears of this region are deservedly noted for their quality. They are, of course, affected by the same plague of worms as the apples, an evil that seems so little regarded that the fruitdealer will sometimes regard your objection to such occupancy with surprise. The yield of prunes promises well, both in quantity and quality, and I think American growers may safely count on the competition of an unusually large and unusually good prune crop from this consular district; scarcely anything can now occur to reduce the quantity, and the weather is not likely to impair the quality. However, the almost universal destruction of all sorts of birds in this part of France, in my opinion, will soon render the production of good fruits well nigh impossible."

Mr. A. M. Thackara, Consul at Havre, says, among other matters: "I have been informed by one of the largest importers of American fruits, that apples are now selling here for future delivery at a price one-third of that asked this time last year. He is of the opinion that there will be no apples or pears imported this year, or, at least, very few. There may be a small business done in prunes in the larger sizes."

Summing up all the data obtainable, I find that there is a very large crop of fruit this year throughout the world to compete with, yet I feel that there is a market, and a fair market for absolutely clean, first-class apples and large-sized prunes, carefully packed, to meet the demand of the best trade. It is a pleasure to state that most of Oregon apples this year are not alone of good size, but, through the care of the progressive orchardists, are, comparatively speaking, free from insects and scab. Our Fellenberg prunes are also very large — ideal conditions to meet this demand.

As a guide of what the demand of apples for export this year will be, I give shipments of the season 1899-1900. The total shipments of apples from all American ports except Pacific Coast, were 1,293,121 barrels distributed as follows:

| | Barrels |
|---|---|
| Liverpool | 644,857 |
| London | 319,869 |
| Glasgow | 211,555 |
| Hamburg | 72,150 |
| Various ports | 44,690 |

In addition to the above there were exported of Pacific Coast apples, *via* New York, 149,515 boxes, distributed among foreign ports as follows:

| | *Boxes.* |
|---|---|
| To Liverpool | 58,922 |
| To London | 70,724 |
| To Glasgow | 13,118 |
| To Hamburg | 4,826 |
| To Hull | 1,925 |

In this connection the complaint comes from European merchants that our boxes are too light. They say apple boxes intended for export should be heavier, and strapped with iron.

In conclusion I desire to state that the loss in the season 1899-1900, on account of poor keeping qualities of apples grown east of the Rocky Mountains and in Canada will make buyers wary, and it is reasonable to expect this to act favorably for Pacific Coast grown apples.

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These reports, which involve a great deal of correspondence and labor, I assumed voluntarily; they have never been attempted heretofore, but have been far-reaching and proven of great value, not alone to the grower and shipper of Oregon, but to dealers in the world's markets. By reason of these reports being published in all the leading papers of our state, growers kept fully informed as to the prices likely to rule in season, and sold their fruits accordingly. Shippers were kept posted as to the outlook in other states, so as to look for the most favorable markets for our choice fruits; but, perhaps the most benefit our growers received is that these reports were copied by hundreds of horticultural and commercial papers throughout the east, and even Europe, drawing the attention of fruitbuyers to our crops, thus opening new markets, and enlarging new fields to operate in. Letters are continually received at this office from dealers abroad, asking to be placed in communication with growers and shippers of Oregon fruits, the superiority of which have been proven time and again. Consumers are beginning to discriminate, and by reason of our exhibits at the Columbian Exposition at Chicago, and Trans-Mississippi Exposition at Omaha, where tons of Oregon fruit were distributed gratuitously to visitors. The placards on fruitstands in large eastern cities, where formerly none were to be seen, now read: "Oregon

Apples," "Oregon Pears," "Oregon Cherries," "Oregon Peaches," etc., which cannot help but be gratifying to our fruitgrowers.

It has been my aim to continually enlarge the usefulness of this office, reaching out in all directions for expansion of our fruit industry; by reason of these efforts, a beginning of fruit shipments to the Orient has been made. Through correspondence with consuls and dealers, it has been learned that there is quite a field for operation in Shanghai, Hong Kong, and other large cities of China, as well as Nagasaki, Tokio, Japan, and even Siberia. A shipment of apples was recently made to Vladivostock, Siberia, which found a very sympathetic market among the Russian inhabitants, with every promise of expansion. One firm in Nagasaki asked me to have shipped to them, last year, as a trial order, one hundred boxes of apples by first steamer, and a like quantity on the following steamer, paying cash for them. These orders were turned over to a commission house in Portland, which filled them with evident satisfaction, as the trade since then has steadily increased. While I do not wish to repeat myself, these Oriental markets are of so much importance that I cannot help talking about it, and recommend the closest investigation of it, as it will give us an outlet for all our surplus fruits. We cannot always expect failures in some of the eastern or European fruit centers for the marketing of our surplus. There are years when all sections have abundant fruit crops, and then the necessity of a market to the west of us will be very apparent; as this is liable to occur at any time, it is well to be prepared. Remember the old adage, "In time of peace prepare for war."

## GERMAN MARKET.

For a number of years I have kept in close touch with Consul-General Frank Mason at Berlin, Germany, where some of our fine Italian prunes found a friendly market, and were sold as high as one mark (twenty-four cents) per pound. He wrote to me recently, and said: "The popularity of American dried and preserved fruit in this country has increased from year to year — by reason of both their relative cheapness and their unrivaled flavor and excellence—until a leading wholesale dealer in such products at Berlin informs this consulate that his applications from his customers—who are mainly grocers

and provision dealers in other towns and cities—are larger this season than ever before, and relate almost exclusively to American fruits.

### OUR PRUNES SUPPLANT FRENCH.

"Pacific Coast prunes are rapidly supplanting the fine but expensive French product and the low-grade Bosnian prunes in the German market, and there is nothing here that can successfully compete with the dried pears and peaches and evaporated apples from the United States. It will, therefore, be of interest to American exporters to know that the tedious and annoying inspection of dried fruits at the German frontier, as a precaution against the supposed danger from the San Jose scale, has been discontinued since the first of last month, so that the way is now open to an unrestricted trade.

"Last year the supply of American dried fruits was insufficient to meet the demands of the German market, but this year large contracts have been made by American merchants, who, after visiting the Paris Exposition, have come to this country, and by way of combining business with travel, have visited the principal German cities and personally offered their products to the more important dealers.

### CAREFUL PACKING NECESSARY.

"As to fresh fruits, the inspections at the frontier will be still maintained, but, it is believed, in a fair and liberal spirit. It is noted in this connection that hitherto cases of San Jose scale have been found most frequently among the highest and most expensive class of apples, such as are wrapped in tissue paper and put up in boxes for family and hotel use, whereas such infection has rarely been detected in the common grade of apples, which are packed loosely in ordinary barrels. This probably results from the fact that the choicest American apples come from a state or district specially infected by the scale, whereas the states along the northern frontier, New York, Michigan, Wisconsin, and Iowa, are generally free from it. It is suggested by the German importers that if, before being wrapped and packed, the high-class apples could be wiped or brushed, especially at the ends of the core, whatever scale exists might be easily removed and thus whole shipments of such expensive fruit, now liable to be condemned, would be enabled to pass the inspection without danger."

THE APPLE AS A COMMERCIAL FRUIT.

Speaking of apples so continually referred to by all consuls and dealers from every foreign port, we stand head and shoulders above our neighbors as producers of fine apples. Oregon has acquired the sobriquet of "The Land of Red Apples," and justly so, ever since that healthy fruit was first introduced by Mr. Luelling in the early forties.

While apples are grown to perfection all over our state, yet certain sections are better adapted for apple culture than others. In our Willamette Valley apples grow everywhere in great profusion, but they have not the keeping qualities of those raised either in Southern or Eastern Oregon, though equally fine flavored and highly colored. Apple trees standing on my own grounds near Portland and planted nearly fifty years ago—Baldwins, Spitzenbergs, Fall Pippins, Gloria Mundi, and Bellefleur—bear as fine fruit to day as they ever did.

The total acreage planted to apples at present in Oregon is about sixteen thousand five hundred acres, but now that it has become apparent that the apple is the commercial fruit, many new plantings are being made, notably in Southern Oregon, Hood River Valley, and the higher plateau regions of Eastern Oregon, where apples can be grown to perfection commercially.

My observation at the Columbian Exposition, held at Chicago in 1893, and more recently at the Trans-Mississippi Exposition at Omaha, led me to the conclusion that the apple is the commercial fruit par excellence of the whole world as a fresh fruit, followed by our fine prunes as an evaporated product. We only need to keep track of production and consumption to become convinced soon that such is the case, as people become more educated, or civilized, so to speak, if you will allow me to use such a terse expression, the more they learn that fruit, especially apples, is the best food for man.

In 1896 America had one of the largest apple crops up to that time, and the cry came from every quarter "over production;" yet this year's crop, which is equally as large, if not larger, finds that prices are very firm — apples which sold in 1896 at New York at seventy-five cents per barrel are quoted this day at $1.50 per barrel, and the market in Oregon is very firm in sympathy with these conditions. First-class four-tier apples are now selling at from eighty-five cents to $1.25 per box, for shipment east and to Europe, and in a short time will reach a higher figure.

What does this all mean?

Just simply this: that the market is better organized. The grower and dealer have come into closer touch with each other for their mutual benefit. Apples have become further distributed than heretofore, and Europe has learned the value of American apples as a food. To illustrate: last spring a commission house sent one car of Newtown Pippins of Southern Oregon growing to Hamburg, in Germany, which were sold for fifteen marks or $3.65 per box. About a month ago a gentleman came into my office and presented his card; he proved to be a commission merchant from Hamburg. He said to me that he was present when this car of apples was auctioned off, and was one of the bidders; he was so impressed with the fine quality of these apples that he came over in person to make arrangements for this winter's supply.

The outlook for the apple in the future, as a commercial fruit, is certainly a most promising one.

A commercial apple orchard, located where climatic and soil conditions are most congenial to their perfection, is one of the best-paying propositions of this day. From observation I find that the demand and consumption of apples increases from year to year, to the exclusion of most other fruits in the fresh state, followed closely by our fine prunes as an evaporated product.

The apple is to the fruit what the potato is to the vegetable line — whenever once introduced, it is there to stay.

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## THE APPLE ORCHARDS OF OREGON.

There is perhaps no more fascinating or ennobling pursuit in life, and possibly none more profitable, than the growing of apples. The poet who has watched and raved over the development of a beautiful girl baby into maiden — and ultimate womanhood — will find its counterpart in an Oregon apple orchard. To stand and watch in early spring the quickening of the apple tree; the gradual development of leaf and bud, and the gentle, timid opening of its bewitching blossoms, filling the air with its intoxicating fragrance; the final fruitage of the magnificent red apples for which Oregon has become famous, is a poem in itself. William Cullen Bryant must have had an Oregon apple orchard in mind when he wrote:

"What plant we in the apple tree?
Sweets from a hundred flowery springs
To load the May wind's restless wings,
When from the orchard row he pours
Its fragrance through the open doors;
A world of blossoms for the bee,
Flowers for the sick girl's silent room,
For the glad infant sprigs of bloom,
We plant with the apple tree."

This healthful fruit has only recently received proper recognition in a commercial way in Oregon since we learned that apples grow to such perfection as to size, color, palatableness, quantity and long-keeping qualities, making it an extra fine article, not alone for home consumption, but for export trade.

In Oregon the planter cannot only find the localities best suited to the different varieties of fruit, but in addition has his choice as to climate. He may select Eastern Oregon with its extreme seasons, the arid lands of this vast inland empire, located east of the Cascade Range of mountains, especially along the canyons and flat areas of the Snake River, which were heretofore considered only fit to grow sagebrush and greasewood, and the home of the jackrabbit and toad, has proved wonderfully fertile under irrigation, and under the management of progressive and up-to-date fruitgrowers. The beautiful valleys that lie scattered throughout the higher plateaus and Blue Mountains, as well as the now famous Hood River Valley, along the Columbia River, and which do not depend upon irrigation, are most fertile spots for the fruitgrower; perhaps nowhere do apples grow to greater perfection as to size, flavor and color than in these valleys.

Southern Oregon tempts him with its enchanting valleys, clear skies and balmy air. The decomposed granite soils, as found in the Rogue River and the Umpqua valleys, offer the same advantages to the horticulturist. The commercial apple orchards in this section, which embrace from one hundred to one hundred and sixty acres, ship their apples mostly to England and Germany, where they have found a sympathetic market at good figures.

Then there is our own Willamette Valley of two hundred miles or more in length, with equable climate throughout the year, which does, and always did, grow fine apples. True, they have not the keeping qualities, owing to our humid climate, of those raised in the more dry localities and higher altitudes. But for size, color and flavor they are not excelled anywhere. Apple-growing is no longer an experiment in

Oregon. The incessant drudgery, the numerous and keen disappointments which are peculiar to all new enterprises, and from which horticulture in Oregon did not escape, are things of the past. We have reached the era of scientific management of the orchard and of remunerative prices for the product. The apple orchards of Oregon are conducted along business lines and scientific basis. They are pruned each season, plowed and cultivated from time to time, as required, and thoroughly sprayed with the proper compounds five or six times each year to combat and subdue fungous diseases and insect pests, notably the codling moth, and in consequence are enabled to market from ninety-five to ninety-eight per cent. of good, clean, wholesome apples. While apples are now selling in the Middle West and East at $1.50 per barrel, our apples bring readily eighty-five cents to $1.25 per box of fifty pounds each, or more than double, as one barrel is equal to three boxes. Many cars of first-class four-tier apples for export trade were sold this week at $1.25 per box.

Horticulture is a special work—an applied science. In it expectations are never realized without painstaking work and trying patience. Good results come only to those, even in this favored state of ours, who go into the business understandingly, give to it their best thoughts and care, manage the apple orchard as they would any other business venture, and keep abreast of the times.

### AMERICA IS A LAND OF FRUITS.

Prof. L. H. Bailey recently said that "America is a land of fruits because, for one thing, its agriculture is so recent and so little bound by tradition, that the farmer feels himself free to discard old and unprofitable enterprises for new and relatively profitable ones." There is, perhaps, no state to which this applies with more force than Oregon, and it can be said truthfully that in the constellation of states none shine brighter in that particular than our own Oregon, especially in the growing of fruit for the export, or, rather, trans-Atlantic and trans-Pacific trade.

This particular trade demands a hard apple, as ocean transportation is a very severe test, but, as I have stated elsewhere, while we grow good apples all over our state, certain localities are better adapted for the growing of hard apples, and such localities should confine themselves to as few varieties as

possible, so that if the trade for a certain kind is once established, the demand can be continually supplied. There is nothing so disastrous in all trades as the substitution of one kind when another is required; the consumer is very discriminating in this particular, and when he wants a Newtown or Spitzenberg he will not accept a Baldwin or a Jonathan if ever so tempting.

Europe wants our fruit and is willing to pay good figures for it, but we must cater to their tastes, and grow what they demand, and not what we wish them to take. The buyer has the privilege to choose, and if we forget that we make a serious mistake.

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## APPLE SHIPMENTS FOR THE SEASON OF 1900.

Early in the season the outlook for a large crop of apples all over the United States was a most promising one, and it looked as though the bountiful year 1896 would be surpassed, and prices rule correspondingly low. When the September gale blew off fifty per cent. of the apples all along the apple-growing states of the Atlantic seaboard, then came the report that over sixty per cent. of the apples in the famous growing states of Missouri, Arkansas, Kansas, Illinois, and Iowa were spoiled by bitter rot and codling moth. In addition to this the remaining fruits failed to mature perfect, but remained small and ill-shaped. This acted very stimulating on the apple market. Dealers and exporters kept the wires hot with inquiries for Oregon apples. In consequence they began to sell at eighty-five cents per box f. o. b., and desirable hard apples, such as Jonathan, Spitzenbergs, Spys, Winesaps, Newtown Pippins are now selling for $1.20 to $1.30 per box f. o. b., with a steady upward tendency. Extra choice apples for local trade readily bring $1.50 to $1.75 per box on this December 1, 1900.

### APPLES SHIPPED TO EUROPE.

Up to December 1, 1900, shipments from Atlantic ports are as follows:

| | *Barrels.* |
|---|---|
| For Liverpool | 266,578 |
| For London | 116,805 |
| For Glasgow | 157,932 |
| For Hamburg | 38,659 |
| For various ports | 23,028 |
| Total | 603,002 |

Up to the same date there were shipped from Oregon, as near as can be ascertained:

| | Boxes. |
|---|---|
| For Liverpool | 42,000 |
| For London | 27,000 |
| For Glasgow | 6,000 |
| For Hamburg | 3,600 |
| For various ports | 3,000 |
| Total | 81,600 |

From the present outlook of stocks on hand it is safe to predict that the total European shipment from Oregon will reach one hundred and fifty thousand boxes.

By way of comparison, I may state that the fruits exported to Germany alone amounted to $456,656 in 1899, and, up to December 1, 1900, to $1,416,596, an increase of over two hundred per cent.

WORLD'S PRUNE CROP.

| | 1899. Pounds. | 1900. Pounds. |
|---|---|---|
| California | 114,227,000 | 125,000,000 |
| Oregon and Washington | 6,000,000 | 15,000,000 |
| France | 20,000,000 | 90,000,000 |
| Bosnia and Servia | 110,000,000 | 83,000,000 |
| Totals | 250,227,000 | 313,000,000 |

Notwithstanding this large increase, our fine Fellenbergs (Italians), and known in eastern markets as the "Oregon Prune," brought very good figures, ranging from four and one-half cents per pound for early sales to six and one-fourth cents for later sales for thirties to forties, while the French prunes sold for two to three cents for the four sizes, sixty to one hundred to the pound. In this connection permit me once more to refer to

EVAPORATORS AND FRUIT EVAPORATION.

In speaking to dealers, packers and shippers I find the universal complaint of lack of uniformity in evaporated prunes from the various growers, and only for this reason I refer to this subject again.

The construction of evaporators on correct principles, and the art of evaporating fruit, has engrossed the minds of scientists and laymen alike, both at home and abroad, and it seems as yet we have not reached the wished-for goal, but we are on a fair way to do it.

To dry fruit is one thing, but to evaporate it quite another — simply to put a lot of fruit on a tray, put it into an oven, fire up and wait until it is shriveled away to a bony state, almost any one can do; but to properly "evaporate" fruit, so it is a fine marketable article, requires a good deal of care and intelligence on the part of the operator.

It is in this, like in all other business or trades, the principles involved must be thoroughly understood, in fact the operator must be educated to it, the same as any master mechanic.

The two great principles involved are heat and circulation. Without these two, it is useless to attempt to make good fruit—it cannot be done. And it matters little whether the heat is supplied by a brick furnace, with large radiating pipes or by coils of steam pipes, so long as it can be controlled; for remember, hot air in space is a very difficult thing to control, and can only be accomplished in a properly-constructed evaporator, with thorough circulation.

I have experimented for many years in fruit evaporation in variously constructed evaporators, and we have made rapid strides forward, and as I said, while we have not yet reached our goal, we are very close to the line. I will not attempt to describe the many patented and non-patented evaporators, all of which have good points, and while some operators can make fair fruit on any one of them, none are yet perfect. My own experience, however, has led me to the conclusion that all fruits must be started at a low heat and finished at a high heat, in order to prevent the loss of the aromatic juices and fruit meats essential to fine fruits; and in order to accomplish this, the evaporator must be so constructed that the trays of fresh fruits are placed in furthest from, and be made to graduallly advance toward, the furnace or steam pipes. There are now two evaporators made in Oregon in which this principle is employed, but it is hardly proper for me to recommend any particular evaporator.

The dipping-in-lye solution, so objectionable to consumers of refined tastes, must be done away with. Thanks to Prof. Hoersch–Durren, this is no longer necessary, as fruits "steamed" prior to evaporation make a much finer product. He says it will open the pores of the skin to facilitate evaporation and prevent dripping; it makes the skin tender and eliminates that leathery substance found in most of our dried French prunes; it requires less heat, and "fruit will dry heavier or more meaty" than unsteamed fruit. This alone is

a strong recommendation, and worth all the trouble and expense. The pressure in the steam box should not be over one-eighth pound, prunes to be subjected from ten to fifteen minutes; pears, fifteen to twenty minutes; and apples, one and one-half to two minutes, and on removal immediately transferred to the evaporator.

Experiments made recently by Mr. Adam Fleckenstein in his new evaporator, in which both the foregoing principles were introduced, proved decidedly successful; French prunes yield forty-five pounds to the hundred, and Italians, thirty-three pounds of evaporated product to one hundred pounds of fresh fruit.

Rapid evaporation, as claimed by some patentees as a point of merit, is a great mistake. Nature, if left to her good offices, will dry fruit very slowly in order to develop the saccharine matter, and the closer we follow her the nearer right we are —nature makes no mistakes. French prunes should never be evaporated in less than twenty-four to thirty hours; Italian and Silver prunes, thirty-six to forty-two hours; apples, in six hours; peeled pears, in twenty-four hours, and unpeeled pears, forty-eight to sixty hours.

I further find by actual experience that prunes should be allowed to cool off while in process of evaporation, or, in other words, the fires should be allowed to go out nights, and relighted in the morning. Experiments made again by myself and some others showed that prunes thus treated were much sweeter, larger, heavier, more golden inside, meaty, and altogether a superior fruit to those which were finished in a continuous heat. I hardly think it necessary to add that all prunes should be dead ripe.

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### POTASH AS A PRUNE FERTILIZER.

While on the topic of prunes, the subject of fertilizing in order to obtain larger prunes should be well understood. It is a known fact that our soils are deficient in potash, and it is another known fact that prunes are gross feeders of potash, most of which goes to form the pit, and if there is any left it helps to put on meat, and if not, the prune will be small. In seasons when but few prunes are on a tree they are uniformly large, because there is usually potash enough for both pit and meat, but if we have a full crop the prunes are sure to be smaller, and sometimes very small, especially so with

the Petites or French prune, because there is not potash enough to go around; hence, we must supply this deficiency by sowing broadcast throughout the prune orchards in the spring, just before the first plowing, from two hundred to four hundred pounds of muriate of potash per acre, and the result will be satisfactory.

In an article published recently in the *Northwest Horticulturist*, Prof. G. W. Shaw gives the reason for the using of potash so concisely that I will give it here in full:

### ABOUT THE USE OF POTASH.

"First—Potash is essential for the assimilation of carbon and its elaboration into starch, giving strength to the cell tissue. Thus the plant suffers greatly in its woody portions in the absence of potash in requisite quantities.

"Second—It is associated with starch in its trans-location from cell to cell, and in its formation into sugar. Hence, the size and quality of fruit is materially affected by a deficiency of potash.

"Third—It is required for a proper development of fruit acids, so important in imparting an agreeable flavor to fruits.

"Having thus set forth the above functions, which science has demonstrated to be true concerning the relation of potash to plant growth, it remains to state the evidence on which rests my belief in the need of potash on the soils of the Northwest, west of the Cascades. Soils are formed by the natural disintegration and abrasion of the original rock masses. This being the case, it follows that a study of the chemical characteristics of the rocks of a specified region will at least give some clue as to what may be expected to be present in relatively large and small quantities in the resulting solid. To illustrate: In regions in which limestone rocks are abundant, soils are materially calcareous. It may be argued that the process of weathering, including the solvent action of the water, changes the proportions in which these soil ingredients are present.

"This I admit in certain cases, but it cannot in any case go so far as to supply material which is not present in the parent rock, nor to make a soil even fairly supplied with an element which is present in only limited quantities in the parent rock, and, in fact, in this particular case, the soluble salts of potash as developed from the insoluble minerals, largely feldspar, as shown by Merrill, will be to a considerable

extent lost, provided the soils thus formed are subjected to heavy leaching, which will be the case throughout the region in question. The character of the parent rock of these soils is mainly basalt, resulting from the great lava overflow, and the lesser subsequent ones which covered the whole of Northern California, and a great part of Oregon, Washington, and Idaho. It is true that basalt is a complex rock, and carries the fertilizing elements of a variety of rock, but it is still further true that the composition of the constituent minerals in the basalt influences the chemical characteristics of the soil.

"The idea that clay soils are rich in potash sprang from the wide predominance of such soils resulting from the orthoclase feldspars of the•east. It is a great mistake to make this conclusion a general one, for the plagioclastic division of feldspars, including, as it does, oliogoclase labradorite, anorthite or andesite, are all non-potash bearing, but it is one or more of the plagioclastic feldspars—soda lime compounds—which exists in the basalts of this region. From a prior reason of soil origin we would expect to find the soil to be quite limited in potash contents. This condition is still more to be expected from the tendency of the potash ingredients toward loss in the progress of soil decomposition. This is illustrated by a rock of this character carrying eighty-one per cent. of potash, after decomposition by weathering showed but twenty per cent., a loss of seventy-one per cent. of the total. Still further, there might be added the annual loss of available potash compounds through the medium of very heavy rains common to this section during the winter months."

## SPRAYING.

This is an old yet ever new subject, and it seems surprising that after so much has been said and written about it that there should still be unbelievers in the beneficial results obtained from spraying, or others meeting with poor results. For this latter there are many reasons, but absolutely none for the former.

In different parts of this report I cite numerous instances of the beneficial results obtained by systematic spraying with the properly prepared compounds, and I do not desire to refer to it again here.

Most failures to achieve good results are reported in spraying for codling moth. In speaking about this to Mr. Olwell of Central Point, who is now most successful in spraying, he tells me, and which is confirmed by my own observations, that the largest percentage of failures is attributable to the settling of the poisons used in the spray tank or barrel, or in other words, the agitator or paddle is not sufficiently used to keep the poisons thoroughly mixed, so the last few trees sprayed out of each barrelful get an overdose, and the rest none. Another reason for the failures is that the spraying is not done often enough, nor late enough in the fall. Six times during the season, or at least every three weeks, is none too often. Prof. E. A. Popenoe, of the Kansas Experiment Station, says, in this connection :

### CAUSES OF FAILURE IN SPRAYING.

"A belief exists in the minds of some fruitgrowers that recommended methods for the destruction of the codling moth are worthless; that spraying with arsenic compounds has proven of no avail. Disregarding the opposition of some whose ill-chosen statements furnish their own refutation, we must still admit that trials of spraying methods by our fruitgrowers have too often resulted in apparent failure, and, in consequence, have measurably destroyed confidence in these methods.

"These reported failures may have come from one of several causes: First, an exaggerated idea of the results to be obtained by spraying has led to anticipations of a degree of success not warranted by the experience of the most successful experimenters; second, proper spraying demands such close adherence to several indispensable points of practice that even careful men may fail through oversight of these particulars; or, finally, the adverse report is made without the just estimate of the result of the experiment; for it will be granted that a true judgment of the degree of success can only be had by the comparison of trees treated with trees untreated in the same surroundings, and this comparison lacking, the estimate of success or failure is altogether a matter of opinion, and not to be admitted as evidence.

"As to the first: No one qualified to advise in the matter will claim that a single season's trial of spraying against the codling moth can alone bring perfect success, especially

where the neighboring fruitgrowers do not follow the same methods, and where these have not been practiced for several years together, or long enough for the cumulative effects to become apparent. It must also be remembered that it is only the worms of the first brood that are killed by the spraying, however effectually done, while from the individuals escaping this attack come the moths that are the parents of the worms that spoil the apples at maturity.

"Moreover, spraying alone, though successful within its own limits, cannot insure the fullest product of perfect apples without the concurrent practice of other methods looking to the final reduction of the numbers of the pest. The most important of these associated methods is the banding of the trees and the destruction of the attracted worms every ten days, from the fall of the first wormy apple till the fruit is all in the bin. The second is the immediate destruction of all fallen wormy fruit; and the third is the destruction of as many as possible of the worms wintering over under bark scales, in old birds' nests, in cracks in apple bins or barrels, or elsewhere in the fruit room. These associated practices are not to be expected to show their full results in the season in which the work is done, though the immediate value of the first is considerable as a means of reducing the number of worms of the second or later broods of the same season.

"It is also possible that some of the reported failures are referable to the use of adulterated or low-grade poison. In several states the experiment stations find greatly inferior samples of paris green on the market; and, while tests made at the Kansas Experiment Station a few years ago showed a fairly uniform high-grade in samples analyzed, it is quite possible that those at present in our market may be found defective, as has been reported from neighboring states.

"It is the purpose of the Kansas station to repeat this year its former careful tests in spraying, if the apple crop gives opportunity, and we hope to be able to correct, by fresh evidence, the idea hastily expressed in some quarters, that spraying against the codling moth is time and money wasted."

## TOP GRAFTING—ITS ADVANTAGES AND POSSIBILITIES.

This topic is suggested by several causes. First, nursery stock purchased which did not prove true to name, and second, the many old, neglected orchards throughout the state. Some twelve years ago I purchased about five hundred trees of various fruits, among which were one hundred French prunes, only about seventy-five being Petites, the others all kinds of little measley plums. Among the cherries I ordered twelve Kentish, only one proved true to name, the other eleven are all sorts of worthless sour cherries, and the trees stand on my grounds today living monuments of man's inhumanity to man, though a stronger term would be more applicable. The same is the case with the apple and pear trees ordered. A few days ago a fruitgrower came to my office for advice along this line. He had bought one hundred apple trees and only fifteen proved true to name. While I feel, and no doubt hundreds of others feel that there should be a severe penalty attached to the selling of nursery stock which proves untrue to name, I do not wish to discuss this outrage at this time.

The question naturally arises, what to do with these trees? The only solution is to topgraft them as soon as possible with the desired varieties; and right here I wish to call attention to the selection of the proper scions. These should be cut only from trees known to bear their fruits to perfection, and by all means, never from nursery stock. Many of the apple trees planted years ago, of varieties now obsolete and no longer salable, are allowed to run riot and waste. All such trees can and should be worked over to such varieties which have a commercial value, and instead of being a nuisance to their owners and neighbors, will become in a very few years objects of pleasure and profit.

Professor Sears discusses this part of the topic very much to the point, in an article recently published, and on account of its valuable suggestions, permit me to give it in full:

"The use of top-grafting in the propagation of the apple is very general in Nova Scotia, where conditions seem to be especially favorable for its success, and my object in the discussion of this is to call attention to some of the advantages to be secured by this method of propagation, but which might, perhaps, be overlooked by the orchardist. Top-grafting, as usually practiced, has this advantage over the other methods of propagation, that we know the character of the stock on which we are grafting, and can, therefore, tell

something of what the effect of this stock will be on the variety we are propagating. That the stock used does influence the scion cannot be doubted, and in proof of this let me cite one or two instances. A most interesting case of this kind was related to me by my friend, Mr. Robert Starr. Briefly stated it was this: Some years ago Mr. Starr bought a dozen Baldwin apple trees, and when they came into bearing it was noticed that one of the trees bore apples a year in advance of any of the others, and the fruit was so highly colored and ripened so early as to be scarcely recognizable as Baldwins; yet the true Baldwin flavor was there, though somewhat intensified, leaving no doubt as to their identity. The last tree of the lot to come into bearing produced very large, light-colored apples that ripened very late indeed, and though, when they finally did ripen, there was no doubt as to their being Baldwins, yet the flavor was exceedingly weak, by no means as pronounced as the typical Baldwin flavor. A few years after sprouts came from below the graft on both trees, and were allowed to grow in order to determine what characters the original stocks had. It was found that these sprouts exhibited showed the same differences which had characterized the apples. In one case they were small and short jointed, reddish in color, both leaves and twigs, and ripened early in the autumn, the leaves falling before frost. In the other case the sprouts were coarse and green, long jointed, and did not stop growing in the fall until nipped by frost.

"Without prolonging further this phase of the discussion, I may say that numerous similar instances might be given, showing conclusively that the characters possessed by the stock are shown to a greater or less degree by the fruit borne on the tree.

"Accepting this as true, let us see what practical application can be made of the principle involved in securing desirable qualities in our fruits, more particularly in apples. First, we recognize that more highly colored fruit is, as a rule, desirable. Is it not possible then to profoundly modify the color of any of our fruit by top-grafting them upon trees of more highly colored sorts? For example, would not Gravensteins be improved in color if they were worked upon Ben Davis trees? Undoubtedly they would. From our present knowledge it cannot be accurately predicted to just what extent this influence would be shown, but enough has already

been stated to show that whatever influence is exerted by the stock will be toward making the fruit approach in color to the fruit borne by the stock.''

Again, as to season of ripening: if so variable and elusive a character as color of fruit is likely to be transmitted, is it not reasonable to expect that the period at which a certain variety ripens might be changed by varying the stocks upon which the variety is grafted? In this connection Prof. Bailey says: '' Grafting often modifies the season of ripening of fruit. This is brought about by different habits of maturity of growth in stock and scion. An experiment with Winter Nellis pears showed that fruit kept longer when grown upon Bloodgood stocks than when grown upon Flemish Beauty stocks. The latter stocks in this case evidently completed their growth sooner than others. Twenty-Ounce apple has been known to ripen in advance of its season by being worked upon Early Harvest. If all this has been done, is it not reasonable to suppose that if the Gravensteins were grafted on the Ben Davis, as was before suggested, not only would the color be improved, but the result would be Gravenstein apples with better keeping qualities? Some one may object here that if the Gravensteins be thus grafted on the Ben Davis, it will not only partake of the character of the latter in color and season of ripening, but in other qualities as well, and we shall have our Gravensteins, the pride of Nova Scotia, tending to become as dry and tasteless as is proverbially the case with the Ben Davis. In answer to this objection I would say that there might be some ground for it; yet it is not a real objection, since in the common practice of root-grafting we graft the Gravenstein unto seedlings, not one in ten thousand of which would probably be equal to the Ben Davis.

'' One other point in this connection is worthy of the most careful consideration, and that is the importance of selecting scions from the best and most prolific trees in propagating any variety. Every observant orchardist knows that certain of his Gravenstein trees, for example, bear more and better fruit than certain others do, and the same is true of other varieties. Not only this, but certain branches of a tree bear better than others. As a proof of this fact that even all branches of the same tree are not alike, I need only to cite the case of the Red Gravenstein, which originated on a single branch of a Gravenstein tree. With these facts before us it is scarcely necessary to state the conclusion that the selection

of scions for grafting deserves greater consideration than it usually receives. What would be thought of a stockbreeder who paid absolutely no attention to the individual characteristics of the animals he bred from? Why, even in an ordinary dairy herd, kept simply for milk, we recognize the importance of individuality, and save the heifers only from the best cows. And yet when it comes to plantbreeding we take scions from any tree, and from any part of the tree—suckers, watersprouts, anything, so long as it is the desired variety. The time has come to make a decided change in this respect, and top-grafting offers the most simple remedy, since it gives an opportunity for each man to select his own scions from his best trees and set them in whatever stock he prefers.

"That in this discussion we are treading upon ground not quite so fully understood as some other fields of horticulture, I am quite well aware; yet it seems to me that we do know enough to warrant the belief that with sufficient care in the selection of stocks and scions we may greatly improve, not only the productiveness of our trees, but the color and keeping qualities of our fruit as well."

In connection with this, Mr. C. G. Patton of Iowa, has done a good deal of experimenting to learn the influence of stock on scion in top-grafting, and among the conclusions he has reached are, that the seedlings of any species make much better unions with varieties of their own kind than with cross seedlings. Old orchards, top-grafted, are longer lived and more fruitful than the same varieties when root-grafted. Top-grafting, when the top and scion are congenial, increases hardiness twenty-five per cent. Varieties productive as root-grafts are also productive when top-worked. The best age for top-working is from three to seven years, and the best time to do it is in March and April.

Among the unions that have been found most satisfactory are the following: Fameuse on Soulard or Hibernal; Yellow Transparent and Fall Orange on Hyslop; Jonathan on Hess; Rebka on Plumb's Cider; Rawle's Genet on Tetofsky; Stark, Baldwin, Longfield, and Utter on Virginia; Ben Davis on Whitney; Wealthy and Grimes on Duchess; Melinda and Pewaukee on Transcendent; Iowa Blush on Alaska. The list is suggestive only, not exhaustive, and local soils and conditions may offset results from these unions.

## INSPECTING ORCHARDS.

The following table has been compiled, for convenience of fruitgrowers and dealers, from the reports of the commissioners on file at this office:

### FIRST DISTRICT.

| | Acres. |
|---|---|
| Apples | 2,234 |
| Pears | 363 |
| Prunes | 3,888 |
| Cherries | 332 |
| Peaches | 36 |
| Mixed | 536 |
| Total | 7,410 |

### SECOND DISTRICT.

| | Acres. |
|---|---|
| Apples | 2,320 |
| Pears | 180 |
| Prunes | 3,115 |
| Cherries | 31 |
| Peaches | 6 |
| Mixed | 186 |
| Total | 5,838 |

### THIRD DISTRICT.

| | Acres, |
|---|---|
| Apples | 2,116 |
| Pears | 367 |
| Prunes | 1,287 |
| Cherries | |
| Peaches | 889 |
| Mixed | 513 |
| Total | 5,172 |

### FOURTH DISTRICT.

| | Acres. |
|---|---|
| Apples | 1,846 |
| Pears | 210 |
| Prunes | 441 |
| Cherries | 117 |
| Peaches | 257 |
| Mixed | 1,162 |
| Total | 4,033 |

### FIFTH DISTRICT.

| | Acres. |
|---|---|
| Apples | 2,212 |
| Pears | 248 |
| Prunes | 998 |
| Cherries | 362 |
| Peaches | 214 |
| Mixed | 264 |
| Total | 4,298 |

### RECAPITULATION.

| | Acres. |
|---|---|
| Total apple orchards | 10,728 |
| Total peach orchards | 1,368 |
| Total prune orchards | 9,729 |
| Total cherry orchards | 843 |
| Total peach orchards | 1,402 |
| Total mixed orchards | 2,481 |
| Grand total | 26,551 |

### TOTAL ACREAGE IN FRUITS.

The total acreage of fruits in Oregon gathered from various sources, is as follows:

| | Acres. |
|---|---|
| Apples | 16,500 |
| Pears | 2,100 |
| Prunes | 27,000 |
| Cherries | 1,200 |
| Peaches | 1,800 |
| Mixed | 4,700 |
| Total | 53,300 |

It will thus be seen that the commissioners have been able to visit and inspect about one-half of the orchards in two years, hence it has been suggested to reduce the districts and add two more commissioners, so justice may be done to all parts of the state.

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### QUARANTINE OFFICER.

As quarantine officer of the Port of Portland, I inspected the fruits arriving and offered for sale in this city, and am pleased to state that, with few exceptions, the fruits were very clean and acceptable. The notices mailed early in the season, to dealers and growers alike, stating that no infected or diseased fruits would be permitted sold, had had a beneficial effect.

I also inspected the nursery stock arriving from without the state, and was compelled to destroy several shipments. The rigid examinations and quarantine of tree shipments has a tendency to check the sending of fruit and ornamental trees, notably from the east, less than ten per cent. arriving now, as compared with former years.

In conclusion, I beg to add that the several thousand letters received by me have all had careful attention and courteous replies, many arriving from without the state, and from intending settlers, asking about horticulture in Oregon. To these inquirers there was also mailed a copy of our fifth biennial report. The edition of five thousand copies of this report is about exhausted, and judging from the demand for it, and the many favorable press notices, this report has done good missionary work.

In compliance with the law, I have attended all horticultural meetings and read papers on pertinent topics wherever invited.

It may be well to add that the fruit industry has received a great stimulus in the last few years—the educational work

done by this board is not alone apparent, but it is appreciated by all progressive horticulturists, and horticulture is destined in the near future to become one of the leading industries in Oregon. Our fine apples, prunes, and strawberries, followed closely by our fine pears, peaches, and cherries, which are not excelled anywhere on earth, have made a reputation for themselves throughout the United States, England, Germany, and France within the last few years, and have reached a very high plane, where they must remain, and not be dragged down again into the whirlpool of ordinary fruit. I feel safe in making the prediction that our progressive up-to-date horticulturists will see to it that the goal for which they have worked so hard, and the high-grade standard and excellence in every respect will be maintained, to the credit of the State of Oregon.

Respectfully submitted,

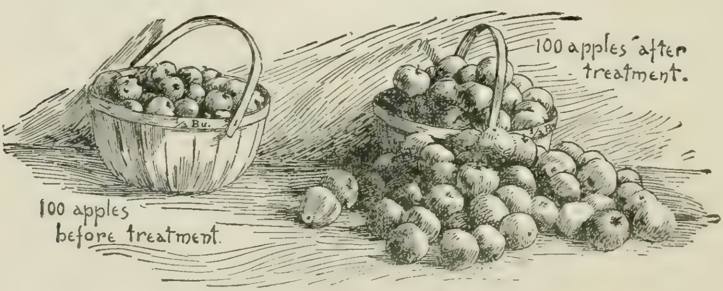
Henry E. Dosch

Secretary.

# SPRAY CALENDAR.

This calendar has been prepared to answer the question, so often asked, *when to spray*, *what to spray with*, *how to spray*, *and what to spray for*, thus obviating the error to use the wrong spray for any given insect or fungi.

All fruit trees should be sprayed in the fall, as soon as all the leaves have dropped, with sulphur, lime, and salt; if no scale are present, full strength of bordeaux mixture will be found sufficient.



## SPRAY NO. 1.

### SULPHUR, LIME, AND SALT.

This is a winter spray, and used for all scale insects, pear-leaf blister mite, green aphis, twig borer, bud moth, and clover mite.

### HOW PREPARED.

*Ingredients*—Lime (unslacked), fifty pounds.
Sulphur, fifty pounds.
Stock salt, fifty pounds.

This will make one hundred and fifty gallons of wash.

*Directions*—Slack fifty pounds of lime, then add the fifty pounds of sulphur, boil it over a brisk fire for one hour, then place all the salt with it in the boiler and boil for fifteen minutes more, then add the necessary water to make one hundred and fifty gallons. This solution should be used at a temperature of at least 100°. Before using, strain it. The utility of this wash depends a great deal upon the strength of the sulphur. It is therefore recommended that those who use this wash have a Beaumes scale for acid. When it shows 8° when cold, it is of the proper strength. These scales can be obtained through any druggist at a cost not to exceed fifty cents.

This combination is the result of Mr. Emile Schanno's extensive experiments in the fourth district.

### FOR SAN JOSE SCALE, GREEDY SCALE, AND TURTLE-BACK SCALE.

Sulphur, lime and salt in the fall as soon as the leaves have dropped, and again in the spring before the buds begin to swell.

### FOR GREEN APHIS.

First application with sulphur, lime and salt in the fall after leaves have dropped, followed in the spring with Spray No. 14, as they appear on the trees.

### FOR PEAR-LEAF BLISTER MITE.

(*Phytoptus Pyri.*)

Until recently the rough, brown-looking spots seen on the pear trees were passed by as being the fungus that attacks the pear so generally here, but upon closer examination it was

found that these spots are the work of this mite. In some localities this pest has gained a strong foothold, and in others it is as yet hardly noticeable. The *Phytoptus pyri* is a microscopic gall mite. It cannot be seen with the naked eye, except on a piece of clear glass held up to the light, when it appears as a minute speck. It is not nearly as long as the width of a hair. It is found only on the pear, the leaves of which are exclusively its home. It burrows into the pulp of the leaves, making a cave in which it lives and multiplies. A colony will work out an excavation, which becomes a slight puff or dark-colored gall on the leaf, from a speck to an eighth of an inch in size. The mite keeps open a hole on the under side of the leaf for a doorway. The injury to tree is caused by the leaves becoming dried and falling. This mite is supposed to desert the leaves after they have fallen, and seek winter quarters upon the tree. It would be a good plan to burn all fallen leaves from affected trees and spray the trees with No. 1 spray as soon as the leaves have dropped. In the summer the mite can be destroyed with powdered sulphur, but it cannot be expected to rid the tree entirely of the mite by this means, as there are eggs and young in the caves, which the sulphur does not affect. In California they use a seeder on a wagon for throwing the sulphur on the affected trees.

*Remedy*—Sulphur, lime and salt before the buds swell, followed by dusting with sulphur when leaves have formed.

### FOR TWIG BORER AND BUD MOTH.

Spray in the fall, as soon as all the leaves have dropped, with sulphur, lime and salt solution, followed up in the spring, as soon as the buds begin to swell, with the following wash: Sulphate of copper, three pounds; lime, four pounds; paris green, four ounces; water, forty-five gallons; and, again, with the same wash the latter part of May.

### FOR CLOVER MITE.

Spray with sulphur, lime and salt in the fall as soon as all the leaves have dropped.

### SPRAY NO. 4.

#### RESIN WASH.

By Professor Koebele.

This is a summer spray for all scale insects, woolly and green aphis.

#### HOW PREPARED.

*Ingredients*—Resin, four pounds.
Sal Soda, three pounds.

*Directions*—Place resin and sal soda in kettle with three pints of cold water. Use soft or rain water always. Boil or simmer slowly until thoroughly dissolved, when it will look black. The sal soda will adhere to the sides of the kettle, and must be scraped down. When it looks dissolved, if there are pieces of resin in the bottom of the kettle it needs more boiling. When sufficiently boiled, add enough hot water to make fifty gallons. After adding the water it will become thick, but after boiling again it becomes thin. The above is ready for immediate use, and should be applied cold or only lukewarm. If desired for future use, boil the above amount of ingredients as directed, and add water to make five gallons; boil until thick. This will stand any length of time, and is always ready for use. When required, use one part or gallon of compound with the following number of gallons of boiling water, and stir thoroughly when applying: For hop louse, one gallon of compound to nine gallons of water; for woolly aphis, one gallon of compound to seven gallons of water; for San Jose scale, one gallon of compound to six gallons of water. The foregoing spray is not injurious to the tree, for after three or four days of sunshine it dissolves and leaves the pores of the bark open.

### SPRAY NO. 7.

#### BORDEAUX MIXTURE.

Used for apple scab, pear scab, leaf blight, apple canker or deadspot, curl-leaf on the peach, crater blight on the pear, gummosis, prune or plum rot, and black rot on the grape.

This is the sovereign remedy against injurious fungous diseases, and its use is general throughout the world; therefore the combination of bluestone and lime, known as bordeaux mixture, is indispensible in fruitgrowing.

### BORDEAUX MIXTURE FOR FUNGI.

*Ingredients* — Sulphate of copper, six pounds.
Lime, four pounds.
Water, forty-five gallons.

### MODIFIED BORDEAUX MIXTURE.

*Ingredients* — Sulphate of copper, three pounds.
Lime, four pounds.
Water, forty-five gallons.

Dissolve bluestone in a wooden vessel, slack the lime in another vessel or can, put both in a barrel of water and mix thoroughly.

### FOR APPLE SCAB, PEAR SCAB AND LEAF BLIGHT.

*First application*— Just as the buds are swelling, with bordeaux mixture.

*Second application*— Just as the fruit buds break open, but before the flowers expand, with bordeaux mixture.


(Ready to spray second time.)

*Third application* —With bordeaux mixture when the fruit has attained the size of a hazelnut.

### FOR APPLE CANKER OR DEADSPOT.

Cut out diseased spots clean in the fall when leaves have dropped, and wash with bordeaux mixture; repeat in midsummer, if found necessary.

FOR CURL-LEAF ON THE PEACH.

Prof. Newton B. Pierce says: "Curl-leaf on the peach is caused by a parasitic fungus which is known as *Taphrina deformans*. The fungus lives within the tissues of the leaf, in the tender shoots, and in the buds. Within the past few months I have learned that lime, sulphur, and salt is a satisfactory preventive of this widespread disease. The application of this spray should be made three to five weeks before the buds open in the spring. The treatment should be very thorough. Or spray with bordeaux mixture six weeks, and again three weeks later, before the buds begin to swell."

FOR CRATER BLIGHT OF PEARS.

Prof. C. W. Woodworth, of Berkeley, California, says: "The nature of the disease is somewhat obscure, but the evidence seems to be that it is caused by an organism, and is very similar to the dreaded eastern pear blight. It is not, however, the same disease. Crater blight first appears as a darkened spot, indistinguishable from any other form of blight. Like other blights, it commonly begins at the point on a branch where a twig is given off, or where one has been. There is this difference, however: The crater blight extends out only below the point of origin, whereas, in other blights, the disease extends upwards as well. The most characteristic feature of this blight is the sharp line of demarcation between the dead and live bark. When a spot has ceased to spread there occurs a breaking in the bark, separating the diseased portion. This soon dries, and the spot appears like a crater. This appearance is most striking when isolated spots are seen on the larger branches."

*Treatment*—Cut out the dead and diseased tissue, clean and wash with bordeaux mixture; cut off all dead and blackened limbs.

Under date of July 27, 1896, Professor Woodworth adds: "We have made some progress in the study of the disease, in that we are very uniformly able to obtain pure cultures of a peculiar bacillus. Inoculation experiments have so far given only negative results. The disease occurs on many varieties of pears and only a few apples. The crater blight certainly occurs in Oregon. I have had very typical examples from there, and obtained the usual bacterial cultures from it. Economically, the crater blight in most localities is unim-

portant, but in some places it has done an immense amount of injury."

### FOR PEAR SCAB, CRACKING, AND LEAF BLIGHT.

These diseases, caused by two different species of fungi, are successfully combatted by one line of treatment. In

most sections all three diseases are found associated. Bordeaux mixture has given the best results in this work. The first spraying for these diseases should be made just before the buds swell. In ten or twelve days the second treatment should be given, followed by a third and fourth at the expiration of two and four weeks, respectively. In the nursery, pear blight is often exceedingly troublesome. It may be almost entirely prevented by spraying five or six times with the bordeaux mixture, making the first application when the leaves are about one-third grown, and the others at intervals of ten or twelve days throughout the season. The leaf blight of the cherry, plum, and quince, which so seriously affects trees, both in the orchard and nursery, may be held in check by using bordeaux mixture.

### FOR PRUNE AND PLUM ROT.

Spray with bordeaux mixture as the buds are swelling, and again when the fruit has attained the size of a bean, with modified bordeaux mixture.

### FOR GUMMOSIS.

Cut out gum pockets, split the outer bark about one-eighth of an inch deep from roots to branches on three sides when sap begins to flow, as all gum-infected trees are barkbound, and wash with bordeaux mixture; care must be taken in splitting the bark not to cut through to the wood; repeat in midsummer, if necessary.

### FOR BLACK ROT ON GRAPES.

Spray with bordeaux mixture just as the buds are swelling, and again immediately after blooming with modified bordeaux mixture.

### LATEST ADVICES ON THE BORDEAUX MIXTURE.

The combination of bluestone and lime, known as the bordeaux mixture, is almost indispensable in fruitgrowing and gardening. It is almost a sovereign remedy against injurious fungi, and its use is general throughout the world. The best way to make the preparation is, consequently, a matter of the greatest moment. The division of vegetable pathology of the department of agriculture has just issued a bulletin on these lines which is very timely. It is four years since there was published, in Farmers' Bulletin No. 7, a summary of the more important methods of combating some of the destructive diseases of fruit. During this time many improvements have been made in the work, and for this and other reasons it seems desirable to now bring together, in brief, practical form, our present knowledge on the subject. The question as to whether it will pay to spray has long since been answered in the affirmative, so it is not necessary at this time to enter upon any argument in regard to this phase of the subject. It is, furthermore, not necessary to go into details as to the relation of spraying to hygiene; suffice it to say, that if the work is properly done no danger whatever to health need be apprehended.

*Superiority of the bordeaux mixture* — During the past four years numerous solutions, powders, etc., have been tested, with a view of determining their value as economical, effective, and practical preventives of fungous parasites. While a number of these preparations have given promise of value, none have been found which fill so many requirements as bordeaux mixture and the ammoniacal solution of copper carbonate. Of the two preparations bordeaux mixture has long been recognized as possessing the most valuable qualities, and it is probably more generally used today than all other fungicides combined. The chief points in its favor are,—(1) its thorough effectiveness as a fungicide; (2) its cheapness; (3) its safety from a hygienic standpoint; (4) its harmlessness to the sprayed plant; and (5) its beneficial effects on plants other than those resulting from the mere prevention of the attack of parasites.

*Bordeaux mixture formula* — All things considered, it is believed that the best results will be obtained from the use of what is known as the fifty-gallon furmula of this preparation, as follows:

*Ingredients* — Water, fifty gallons.
Copper sulphate, six pounds.
Unslacked lime, four pounds.

*Must be well made* — It has been found that the method of combining the ingredients has an important bearing on both the chemical composition and physical structure of the mixture. For example, if the copper sulphate is dissolved in a small quantity of water and the lime milk diluted to a limited extent only, there results, when these materials are brought together, a thick mixture, having strikingly different characters from one made by pouring together weak solutions of lime and copper sulphate. It is true, furthermore, that if the copper sulphate solution and lime milk are poured together while the latter, or both, are warm, different effects are obtained than if both solutions are cool at the moment of mixing. Where the mixture has been properly made there is scarcely any settling after an hour, while the improperly made mixture has settled more than half.

*How to make it* — Briefly, the best results have been obtained from the use of the bordeaux mixture, made in accordance with the following directions: In a barrel, or other suitable vessel, place twenty-five gallons of water; weigh out six pounds of copper sulphate, then tie the same in a piece of coarse gunnysack and suspend it just beneath the surface of the water. By tying the bag to a stick laid across the top of the barrel no further attention will be required. In another vessel slack four pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this it is best to place the lime in an ordinary water pail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear add another quart or more, exercising care that the lime at no time gets too dry. Toward the last considerable water will be required, but, if added carefully and slowly, a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked add sufficient water to the paste to bring the whole up to twenty-five gallons. When the copper sulphate is entirely dissolved and the lime is cool, pour the lime milk and copper sulphate solution slowly together into a

barrel holding fifty gallons. The milk of lime should be thoroughly stirred before pouring. The method described insures good mixing, but to complete this work the barrel of liquid should receive a final stirring for at least three minutes with a broad wooden paddle.

*Testing the mixture.*—It is now necessary to determine whether the mixture is perfect—that is, if it will be safe to apply it to tender foliage. To accomplish this two simple tests may be used. First, insert the blade of a penknife in the mixture, allowing it to remain there for at least one minute; if metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as perfect as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more milk of lime should be added.

*Preparing large amounts*—The foregoing directions apply to cases where small quantities of the mixture are needed for more or less immediate use. If spraying is to be done upon a large scale, it will be found much more convenient and economical in every way to prepare what is known as stock solutions of both the copper and lime. To prepare a stock solution of copper sulphate, procure a barrel holding fifty gallons; weigh out one hundred pounds of copper sulphate, and, after tying it in a sack, suspend it so that it will hang as near the top of the barrel as possible; fill the barrel with water, and in two or three days the copper will be dissolved; now remove the sack and add enough water to bring the solution again up to the fifty-gallon mark, previously made on the barrel. It will be understood, of course, that this second adding of water is merely to replace the space previously occupied by the sack and the crystals of copper sulphate. Each gallon of the solution thus made will contain two pounds of copper sulphate, and, under all ordinary conditions of temperature, there will be no material crystalization, so that the stock preparation may be kept indefinitely.

Stock lime may be prepared in much the same way as the copper sulphate solution. Procure a barrel holding fifty gallons, making a mark to indicate the fifty gallon point; weigh out one hundred pounds of fresh lime, place it in the barrel and slack it; when slacked, add sufficient water to bring the whole mass up to fifty gallons. Each gallon of this preparation contains, after thorough stirring, two pounds of lime.

When it is desired to make bordeaux mixture of the fifty-gallon formula, it is only necessary to measure out three gallons of the stock copper solution, and, after thorough stirring, two gallons of the stock lime; dilute each to twenty-five gallons, mix, stir, and test as already described. One test will be sufficient in this case. In other words, it will not be necessary to test each lot of bordeaux mixture made from the stock preparation, provided the first lot is perfect, and no change is made in the quantities of the material used. Special care should be taken to see that the lime milk is stirred thoroughly each time before applying. As a final precaution, it will be well to keep both the stock copper sulphate and the stock lime tightly covered.

## SPRAY NO. 10.

### PARIS GREEN SPRAY—ARSENITE OF LIME SPRAY.

These sprays are used for codling moth larvæ, tingis, caterpillars, slugs and all eating or biting insects.

### PARIS GREEN SPRAY.

*Proportions for first application*—
Paris green, four ounces.
Lime, two pounds.
Water, forty gallons.
*Proportions for later applications*—
Paris green, four ounces.
Lime, one pound.
Water, fifty gallons.

*Directions*—Slack the lime; make a paste of the paris green, mix thoroughly, and then add water to make the required amount; stir thoroughly while using, and should be thrown on the leaves and fruit in a fine spray.

Paris green is one of our commercial articles which is shamefully adulterated. The foregoing formula is based upon pure paris green; it is, therefore, of much importance that

one be able to detect impurities. So far as we know but two adulterants are used—gypsum and Glauber's salts. The method generally given for the detection of adulteration is to dissolve a small sample of the paris green in ammonia. If there is any gypsum it will not dissolve, but forms a sediment. Glauber's salts cannot be detected by this method, it being equally as soluble as pure paris green ; but if one has a strong microscope at hand the adulterant granules can be easily detected, they being white, while the pure article is green. Ammonia, however, is generally a good test, gypsum being most commonly used as an adulterant.

### THE ARSENITE OF LIME SPRAY.

Professor Kedzie's formulæ :

*Ingredients*—Commercial white arsenic, one pound.
Carbonate of soda, four pounds.
Water, two gallons.

Use one and one-half pints to fifty gallons of bordeaux mixture.

*Directions*—Dissolve one pound of commercial white arsenic and four pounds of carbonate of soda (washing soda) in two gallons of water, and use one and one-half pints to fifty gallons of bordeaux mixture. The easiest way to make the solution is to put both the white arsenic and carbonate of soda in a gallon of boiling water and keep boiling about fifteen minutes, or until clear liquid is formed, then dilute to two gallons. One and one-half pints of this solution should be added to each barrel of full-strength bordeaux mixture for earlier sprayings, and modified bordeaux mixture for late sprayings, increasing the arsenite solution gradually from one and one-half pints to one quart as the season advances and foliage matures. If used without bordeaux mixture or lime, it is liable to burn the foliage. As there is nearly always fungus to contend with, it is recommended that the two sprays be combined, with the additional advantage of making the poison stick longer. Unless combined with bordeaux mixture, it is very important to use enough freshly slacked lime to insure the complete decomposition of arsenite of soda and formation of arsenite of lime. Use six to eight pounds of quicklime, freshly slacked, to a barrel of water.

### FOR CODLING MOTH.

Paris green or arsenite of lime. First spraying, ten days after blossoms have fallen, and then at intervals not exceeding

three weeks, up to within three weeks of harvesting the apples or pears. The arsenite of lime is preferably used with bordeaux mixture, and, as the season advances and foliage matures, increase the arsenite solution gradually from one and one-half pints to one quart to the fifty gallons of bordeaux mixture.

FOR TINGIS, CATERPILLARS AND SLUGS.

Spray as they hatch and appear on the leaves.

## SPRAY NO. 14.

TOBACCO WASH.

Used for green aphis and tingis as they appear on the trees.

HOW PREPARED.

*Ingredients*—Tobacco (sheep dip, sulphured tobacco), four pounds.
Whale-oil soap (or good strong soap), four pounds.
Water, twenty gallons.

*Directions*—Soak the tobacco in hot water for several hours; dissolve the soap in hot water; strain both ingredients; add together and dilute to twenty gallons. On varieties of trees where the foliage is very tender, tests should be made before applying extensively.

KEROSENE EMULSION.

Used for woolly aphis and clover mite.

FOR WOOLLY APHIS.

Spray with kerosene emulsion diluted (7) seven times.

FOR CLOVER MITE.

Spray with kerosene emulsion diluted (8) eight times.

HOW PREPARED—KEROSENE EMULSION (GOVERNMENT FORMULA).

*Ingredients*—Kerosene, two gallons.
Water, one gallon.
Hard soap, one-half pound.

*Directions*—Make a suds of the soap and water and pour

boiling hot into the kerosene; churn with a force pump or a syringe, pumping out of and into a bucket or barrel through a nozzle until completely emulsified. If the mixture is sufficiently hot, it will thicken in from five to ten minutes, and will be, when cold, of the consistency of butter or of soft soap. Dilute with seven to twelve parts of water to one of emulsion, as occasion requires, and this will kill almost anything in the form of plant lice.

### FOR CURRANT AND GOOSEBERRY WORM.

Spray the bushes just before blooming, and again after the fruit has set, with one large tablespoonful of powdered white hellebore, dissolved in two and one-half gallons of water.

### HYDROCYANIC ACID GAS FOR NURSERY STOCK.

*Ingredients*—C. P. cyanide of potassium, twenty-eight per cent., one ounce.
Sulphuric acid, one fluid ounce.
Water, two fluid ounces.

*Directions*—First place the vessel in which the gas is to be generated in a convenient place in the shed, and then put in the cyanide of potassium; pour the water over the cyanide, and then add the sulphuric acid very slowly. Close the door and submit the trees to the fumes for about forty minutes. Open the door and allow the gas to escape before attempting to remove the trees, as it is poisonous to inhale.

### REMEDY FOR APHIS (LICE) ON CABBAGE, CAULIFLOWER, TURNIPS, ETC.

*Ingredients*—Quassia chips, one pound.
Whale-oil soap, one pound.
Water, one gallon.

*Directions*—Boil quassia chips for five hours, then add whale-oil soap, while boiling; when dissolved, dilute to ten gallons of water and spray warm.

### PEACH-ROOT BORER.

The worst insect pest of the prune and peach trees in the Willamette Valley, and probably over the entire state, is the peach-root borer. The moth lays its eggs at the base of the tree in the months of May, June, July, and August. The

eggs hatch in about a week, and the worm at once begins to gnaw the bark and bore its way down into the roots. It lives in the root for one year, and comes forth a winged insect the succeeding spring and summer, and lays the eggs for the next brood, as stated. The presence of the worm is always betrayed by the copious exudation of gum, which issues from the roots at the base of the trunk.

*Remedies*—There are a large number of remedies for this pest which are more or less successful, but where trees are cultivated on a large scale many of the remedies become entirely too expensive. A very popular and successful plan in the peach region of the east is "mounding." Early in the spring, before the moth appears, the earth is drawn about the base of the tree to the height of twelve inches, and removed later in the season, about September 1, in this climate. The use of washes intended to poison the worm have been much used, the following formula being the most successful:

*Ingredients*—Corrosive sublimate (poison), two ounces.
Hard soap; five pounds to ten gallons of water.
Alcohol, one pint.
Water, sufficient.

*Directions*—Dissolve the sublimate in the spirits; stir it into the soap solution; add water sufficient to make a good paint; apply with stiff brush from three inches below to six inches above ground. This must be done as soon as the first moth appears in the spring. The worm will be poisoned by the corrosive sublimate almost at the first mouthful. Great care should be observed in using this wash, as it is very poisonous and dangerous to have about the house.

Of all the remedies we have known none has proven so sure and practical as cutting the grubs out with a knife and preventing their return by wrapping. In the fall of the year remove the earth carefully from the base of the tree; locate the worms and cut them out with a knife. Repeat this in the spring about April, and at the same time wrap the trunk of the tree with stiff paper or other close material, allowing it to extend six inches above and three inches below the ground. This will prevent the moth from laying her eggs in the bark, and is the surest way we know of to defeat the ravages of this insect. Raubenleim and Dendrolene are used in Europe.

The best wash for borers, all considered, that we have seen or tested, is made by the union of all the above ingredients in the following way: Dissolve as much common washing soda

as possible in six gallons of water, then dissolve one gallon of ordinary soft soap in the above and add one pint of crude carbolic acid and thoroughly mix; slack a quantity of lime in four gallons of water so that when it is added to the above, the whole will make a thick whitewash; add this to the above and mix thoroughly, and finally add one-half pound of paris green or one-fourth pound of powdered white arsenic and mix it thoroughly in the above.—*Prof. J. M. Stedman.*

### FOR NURSERY STOCK.

Use No. 1 spray as soon as the leaves have dropped; again in spring, as first leaves appear, with modified bordeaux mixture; fumigate all trees and shrubs with hydrocyanic acid gas before shipping.

### RECIPE FOR GRAFTING WAX.

One of the best grafting waxes is made by melting together four parts—by weight—of resin, one part beeswax, one part tallow. When thoroughly melted, pour into cold water; when cool enough, take out and work by molding and pulling until it becomes quite stiff. It is neccessary to have the hands well greased with tallow while handling this wax.—*From the Yearbook of the United States Department of Agriculture.*

### INSECTS.

Prof. Willis G. Johnson says: "At the present time, spraying is an important part of successful fruitgrowing. The regular and systematic application of insecticides and fungicides is one of the most valuable and profitable pieces of work done on the farm. The spray-pump, properly used, is worth as much to the growers of fruits and vegetables as the policy covering the insurance on his house or barn. In fact, you must 'insure' your crops from destructive insects and fungi, by practicing modern methods of spraying. There has been a decided awakening to the truthfulness of the above statement in the past few years, and thousands of growers are now spraying and seeking information, where only a short time ago they were counted by hundreds."

In order that our readers may understand why one remedy is used for one insect and not for another it will be necessary for us to make some brief references to the structure and habits of certain types. For example, the great mass of injury to

plants by insects falls under two heads: first, where the plant itself has been eaten, and second, where the juices have been sucked out, leaving the tissues.

*Biting Insects*—Insects causing injury of the first class are called biting or chewing insects, familiar examples of which are the beetles, grasshoppers, and caterpillars, such as the cabbage worm, army worm, etc. They have well-developed jaws, fitted for cutting and chewing the plant. Such insects can be destroyed by use of direct poisons, such as the arsenicals. Where applied to the leaves or other parts of the plant it is eaten by the insect, causing its death.

*Sucking Insects*—On the other hand, the second type have long lance-like beaks, fitted for sucking. This class includes the scale insects, plant lice, squash bug, harlequin or terrapin bug, etc. They obtain their food supply by inserting their beaks into the tissues of the plants, sucking the juices from within. The external application of arsenical poisons to plants would have little if any effect upon this group of insects, as the poisons do not enter into the cells of the plants. It is necessary, therefore, to employ some other substances for their destruction. To this end materials are used which will act externally on the bodies of the insects, either as a caustic or to smother or stifle them by closing their breathing organs. I might say in this place that insects do not breathe through their mouths, as do higher animals, but through small openings on either side of the body, called spiracles. By spraying anything of a caustic or oily nature over the body of an insect these spiracles are closed and the creature is destroyed. Sometimes the fumes of poisonous gases are employed to suffocate insects, as will be described later on. Insects are sometimes repelled by obnoxious substances.

The above remarks apply especially to insects which feed upon the exterior of plants or pass the greater portion of their lives in an exposed condition, where they can be readily reached by one of the methods mentioned. Certain other insects, of both classes, biting and sucking, are subterranean in their habits, that is, they feed and live upon the roots of plants below the surface of the ground. Among these the white grub and root lice are common examples. Still other insects live in stored grain, seeds, and the manufactured products of the mill, and even the mill itself. Here again the arsenics and irritants cannot be used and we must resort to various fumes and gases.

## FUNGI.

Professor Charles O. Townsend says:

### WHAT IS A FUNGUS?

A fungus (plural fungi) is a low form of plant. It has neither green stem nor leaves and therefore depends for its food upon other plants or upon animals. Sometimes fungi lives upon dead plants or animals or upon their products, and sometimes they live upon other living plants or upon living animals. They are very numerous and differ greatly among themselves in form, structure and habits of life. All fungi sooner or later produce small, round or oval bodies called spores. These spores under favorable conditions produce new fungi. They are not destroyed by ordinary weather conditions and often live over the winter in the fields and orchards. Sometimes they remain alive for several years in the soil and other suitable places, and begin their growth when the conditions are favorable. Many fungi are very small and can be seen only when greatly magnified.

### WHAT IS THE HOST-PLANT?

The host-plant is the plant upon which, or in which, the fungus lives and from which it draws its food supplies.

### WHAT IS A FUNGICIDE?

A fungicide is any substance which may be used to destroy fungi or their spores, or which will prevent fungi from establishing themselves upon the host-plants. Fungicides may be either solids, liquids, or gases. The most common form of fungicide is liquid; the kind of fungicide used, however, must depend upon the nature of the fungus, the nature of the host-plant, and the part of the host-plant attacked by the fungus.

### WHY SHOULD WE SPRAY?

Liquid fungicides are best applied in the form of a fine mist or spray. This is economy, both in the quantity of material used, and in the time required to apply it. The real object in spraying is to prevent the fungous spores that have lodged upon the foliage, branches, or fruit, from germinating and producing fungous growths. Every fungus that grows

into a leaf or into a fruit, and thus produces the destruction of the former or the decay of the latter, first lodges on the leaf or on the fruit as a tiny spore. If that spore can be destroyed without injury to the leaf or the fruit, disease may be prevented, and therefore the necessity of spraying.

### WHY SHOULD WE SPRAY EARLY?

As already stated fungus spores are sometimes formed in the fall and remain in open fields all winter uninjured. These spores often lodge in the crevices of the bark of trees, or in other convenient places on the trunk and branches of trees. When the leaves and fruits appear the spores are blown onto these newly formed parts and cause them to be diseased. The object in early spraying, even while the trees are still dormant, is to kill the spores that are lodging on the tree and waiting for favorable conditions for development. Again, every spore must remain for a longer or shorter time in a dormant state, even after it reaches the proper place for its development, just as seeds remain for a little time under proper conditions for germination before they begin their growth. If the leaves or other plant parts are covered with a fungicide before or immediately after the spores are blown onto them, the spores will be destroyed, and the plant will remain free from disease.

### WHY IS IT NECESSARY TO SPRAY MORE THAN ONCE?

After a plant has been sprayed new leaves or fruits are often formed, which are not covered with the fungicide. Spores may be lodged on these newly formed parts and develop into fungous growths, causing the parts attacked to be diseased. Or the fungicide originally sprayed onto the plant may be washed off by rains, thus leaving the plant unprotected against the spores that are constantly carried about in the air.

### HOW OFTEN IS IT NECESSARY TO SPRAY?

No definite rule can be given in regard to the number of times any set of plants should be sprayed in a single season. The number of sprayings must depend to a large extent upon weather conditions. Warm, damp weather or a dry, hot season followed by rain, are favorable conditions for the development of fungi, hence, if these conditions prevail, it is

important that the spraying should be frequent enough to keep well protected the parts liable to attack. Sometimes it is necessary to spray every day or every two or three days, while at other times ten days may elapse between sprayings. Spraying, like cultivation, pruning, and other field operations, is largely a matter of judgment, and the more thoroughly the subject is understood the more effective the work will be.

### WHY IS IT NECESSARY TO SPRAY EVERY YEAR?

It is impossible to exterminate fungi. We may hold them in check, or we may even prevent entirely their growth upon certain plants; but they are often so small, their habits of life so variable, and their spores so resistant that extermination is out of the question. It is impossible to know at the beginning of the season whether the conditions will be favorable or unfavorable for the development of fungi, hence, in order to be on the safe side, it is necessary to begin each season with spraying. It is essential, therefore, that spraying should be as regularly a part of the field work for successful crop raising as plowing, fertilizing, and the other operations necessary for crop production. Furthermore, the effects of spraying are cumulative, that is, the effects of spraying and keeping fruit trees free from disease this year will give a better crop next year. Even with trucking crops that die down in the fall the danger from disease next year in a particular field will be greatly reduced if the field is kept free from diseases this season.

### DOES SPRAYING SOMETIMES INJURE FOLIAGE AND FRUIT?

If fungicides are not properly made they will burn the foliage and discolor the fruit. It is a well-known fact that the foliage on some plants is much more tender than it is on others, and for this reason it is necessary to suit the strength of the fungicide to the host-plant. Certain fungicides, like bordeaux mixture, cannot be used in spraying fruit that is nearly ripe, since the fruit would be stained by the mixture, and thereby rendered unsalable.

### WHY DOES SPRAYING SOMETIMES FAIL TO PREVENT DISEASE?

There are several reasons why spraying sometimes fails to accomplish the results expected. It may be that the fungi-

cide was not properly made, that the spraying was not done early enough in the season, or that the applications were not thorough or persistent enough. If we wait until we see the disease at work before we begin spraying our efforts will not result in success, for the reason that when we see the disease it is certain that the fungus spores have germinated and the fungus has grown into the affected part of the host-plant. In such cases it is impossible to destroy the fungus without destroying the diseased part of the host. The most that can be hoped for in such cases is that the disease may be prevented from spreading to the healthy plants or plant parts. If the spraying is not thorough, so that all parts of the host are covered, spores may fall upon the unprotected parts and grow as readily as if no fungicide had been used. Or if the applications are not frequent enough, so that the fungicide is washed off, or new plant parts are developed and left unsprayed, attacks of fungi may take place as readily as if no spraying had been done. It should be remembered that no fungicide will restore any plant part once destroyed or injured, hence the necessity of preventing attacks of fungi, and this can be done by an early, thorough, and persistent use of fungicides.

### WILL SPRAYING PREVENT ALL PLANT DISEASES?

Several plant diseases, of which "peach yellows" is an example, are not, so far as known, produced by organisms, and these diseases can be neither prevented nor controlled by fungicides.

Other plant diseases are produced by bacteria that live in the tissues of diseased plants. These minute organisms seldom appear on the surface of the host-plant and consequently would not usually be reached by spraying. Such a disease is the pear blight. It is often the case that a disease attacks only the underground portion of the plant. It is clear that a disease of this nature could not be prevented or controlled by spraying. Potato scab is an example of diseases of this kind. In short, it is only those fungous diseases that originate from spores on the aboveground portions of plants that may be prevented by spraying.

### WILL IT PAY TO SPRAY?

Whether it will or will not pay to spray must depend upon circumstances. It is of prime importance to know whether

the plants under consideration are subject to diseases that may be prevented by spraying. If so, and the crop is worth raising at all, it is worth bringing to the highest possible state of perfection, and it is now well known that spraying, if properly done, is one of the important factors in perfect crop production. However, unless one makes up his mind to use all possible pains in the preparation of fungicides, to begin spraying early and to carry it on persistently, the time, labor and money expended will be lost. On the other hand, if the fungicide is properly prepared and the work is timely and thorough, it is probable that no equal amount of labor and money expended will yield larger returns, taking it year in and year out. This statement has been demonstrated many times by farmers, gardeners and fruitgrowers in nearly every section of the state. It is true that certain seasons are unfavorable for the development of fungi, but it rarely happens that they do not develop to some extent; hence it will be an advantage to spray even during such seasons. Experience has shown that it pays to spray systematically and thoroughly, year after year, regardless of the season.

# PLANTING TABLE.

So many mistakes have been made in planting trees too close together, that again we give a general table, taking in consideration the strength of soil, variety and nature of the tree, as well as climatic conditions:

DISTANCES.

| | *Feet.* |
|---|---|
| Pears | 24 to 30 |
| Apples | 30 to 40 |
| Apricots | 20 to 22 |
| Cherries | 25 to 30 |
| Peaches | 20 to 25 |
| Prunes and plums | 20 |
| Nut-bearing trees | 30 to 40 |

## NUMBER OF TREES TO THE ACRE.

| | *Square.* | *Triangular.* | *Quincunx.* |
|---|---|---|---|
| Ten feet | 436 | 500 | 831 |
| Twelve feet | 303 | 347 | 571 |
| Fourteen feet | 222 | 255 | 415 |
| Sixteen feet | 170 | 195 | 317 |
| Eighteen feet | 134 | 154 | 249 |
| Twenty feet | 108 | 126 | 193 |
| Twenty-two feet | 90 | 103 | 177 |
| Twenty-four feet | 76 | 86 | 133 |
| Thirty feet | 48 | 56 | 83 |
| Forty feet | 27 | | |

# APPENDIX.

# THE HELPING HAND.

If I should see
A brother languishing in sore distress
And I should turn and leave him comfortless,
When I might be
A messenger of hope and happiness—
How could I ask what I denied
In my own hour of bitterness supplied?

If I might sing
A little song to cheer a fainting heart
And I should seal my lips and sit apart
When I might bring
A bit of sunshine for life's ache and smart—
How could I hope to have my grief relieved
If I kept silent when my brother grieved?

And so I know
That day is lost wherein I fail to lend
A helping hand unto some wayward friend;
But if it show
A burden lightened by the cheer I sent,
Then do I hold the golden hours well spent,
And lay me down to rest in sweet content.

—*Edith V. Brandt.*

# TRANSITION IN AGRICULTURE.

**Read at the Northwest Fruitgrowers' Convention—E. L. SMITH, Hood River.**

Qualification is the watchword of the hour. The horizon of human intelligence has wonderfully expanded during the last half hour of the century now drawing to a close. The Magi of the Orient who interpreted dreams, read the stars, or sought the alchemy that would transmute the the baser metals to gold sink into insignificance when contrasted with the wise men of the West who invoked the hidden forces of nature to perform the service of man. With Bessemer converting iron to steel, a metal of infinitely greater utility than gold: with Edison, the wizzard of Menlo Park, exploring electrical science: with Roentgen sending his cross rays through the human anatomy or wall of iron and revealing their secrets: with Marconi and his wireless telegraphy, or with Fessenden, who astounds us with the intimation that our thoughts can be volted across the broad Atlantic, the only conductor the blue ether of the heavens.

Agriculture, and when I speak of agriculture, I include horticulture and every branch of industry related to the soil, has shared in the wonderful development that has come to all the industrial arts during the past fifty years. The hand sickle and the cradle of our boyhood days have been followed by the reaper, the header, the self-binder, and finally by the combined machine, drawn by a multitude of horses, cutting, thrashing, and sacking forty acres in a single day. The music of the flail sounding on the old barn floor is no longer heard, but instead the roar of great machines with thirty-two, thirty-eight, or forty-inch cylinders, propelled by steam and belching out rivers of straw and golden grain.

And who shall number the varieties, of surpassing excellence, that the horticulturist has given to the world during the past fifty years, but we tarry only to point to a Burbank creating new species of fruit, of color and flavor, to suit his pleasure, to the astonishment and the delight of all pomologists.

And what a prime factor is transportation in the evolution of this great industry. The steel rail intersects all our fertile areas, to bear away the products of orchard and field, and great transports, styled whaleback, with a capacity up to a quarter of a million bushels of grain, go down the great lakes to Cleveland and Buffalo, to immense elevators, that snatch up their cargoes and distribute them to the bread-eaters of the world. Wonderful indeed has been the development of the mechanical appliances of agriculture, and in this respect but little seems lacking. I approach now to the more important part of my message. In this age of transition and of high intelligent standards, let us inquire as to what has been done and what we propose to do for the education of the man in partnership with soil.

## AGRICULTURAL COLLEGES.

The general government seemed tardy in recognition of the importance of this subject, for it was not until 1855 that the first agricultural college was established, at Cleveland, Ohio; the second in 1857, at Lansing, Michigan.

In 1862 the Department of Agriculture was placed in charge of a commissioner at Washington, and in the same year congress appropriated to the several states an amount of public lands equal to thirty thousand acres for each senator and representative, the proceeds of sales to constitute a per-

petual fund, the accruing revenue to be devoted to the maintenance of at least one college in each state, whose leading objects shall be to teach such branches of learning as are related to agriculture and the mechanic arts.

In 1887 congress passed what is known as the "Hatch Act Establishing Experiment Stations," and appropriating for each $15,000 annually, to promote scientific investigation and experiment respecting the principles and application of agricultural science. In 1890 the Morrill act made further liberal appropriation for the more complete endowment of agricultural colleges, and the respective states from time to time extended aid to these schools.

We are informed by Doctor True, in charge of the office of experiment stations at Washington, that we now have sixty-four agricultural colleges, with resources amounting to $53,500,000, and that $10,000,000 had been expended on our experiment stations.

Have the objects contemplated by congress in making these liberal appropriations, the wisdom of which is beyond question, so far as agricultural education is concerned, been realized in Oregon, Washington and Idaho, the three states represented in this association? Some time since it was my pleasure to attend chapel exercises at one of these colleges, and after song, scripture reading and prayer, a visiting graduate was called upon to address the assembled students. I gathered from his remarks that he was taking a law course, and the thought came to me, are these schools breeding lawyers and professional men instead of farmers and fruitgrowers? And since that morning that thought has come to me again and again, and quite recently I addressed a note to one or more of the professors at Corvallis, Pullman, and Moscow, requesting to know how many of the graduates were following husbandry, and how many at the present time were enrolled in agricultural courses. I thank these gentlemen for prompt and courteous acknowledgments, but they disclosed a condition of affairs most discouraging to every man who wants to see the science of agriculture exalted in our schools commensurate with the supreme importance that it bears in the economy of the world. In the University of Idaho there were three students in agriculture in the class of 1898, six in 1899; students enrolled, one hundred and eighty-three. Washington Agricultural College graduated twenty-seven students up to last year—two in agriculture, one in horticulture. In the senior class for 1899 not one student in agriculture. Of the three hundred and twenty-five students enrolled in this institution last December, only fifteen in agricultural and horticultural courses. There were thirty-two or thirty-three members in the class of 1898 at Corvallis, and four or five in agriculture. Class of 1899, thirty-four members, six in agricultural courses. Total enrollment, three hundred and fifty; girls, one hundred and thirty-one; boys, two hundred and ninety-nine. In agricultural courses all told, forty-five or forty-six. In these three "farmers' schools," of eight hundred and seventy-one students enrolled, only fifty-four—less than six and one-half per cent. in agriculture and horticulture. Fellow horticulturist, are you satisfied with this exhibit? If not, where lies the fault and where is the remedy?

There is nothing farther from my thought than to deprecate the value of these schools. I acknowledge my personal indebtedness for the valuable investigation of the experiment stations. I thoroughly appreciate the short courses in agriculture, and yet more the educational work that is being done at farmers' and fruitgrowers' institutes throughout the country. I admit that the usefulness of these schools has been lessened from the fact that from time to time they have been buffeted by political partisanship, that too many of their regents have had no direct interest in the soil or mechanic arts and too many of their presidents and officers have no special training along lines that afford knowledge and bring them in sympathy with industrial arts. But let us not hide behind the shortcomings of our technical schools, for I am convinced that the greater fault lies in our own apathy and indifference to the subject of scientific agriculture. Why do our sons drift into every occupation save that of the farm? Is it because the old

folks want a lawyer or a preacher or a doctor, professions now hopelessly overcrowded, in the family? Is it because he rebels at toiling alongside of the tramp who sleeps in the barn, and that there is too little of the golden rule exercised between the employer and the employed? Is it because civil and mining engineering and electrical science offer greater possibilities? Are these among the causes that lead the boys to drift away from the agricultural courses at our colleges? We have the diagnosis, and I ask you, gentlemen, to point the remedy. After much thought and correspondence with those whose opinions are entitled to greater weight than my own, I conclude that we must first arouse the interest of the parent, and then, as the public schools are the recruiting stations of our colleges, demand that our boards of education prepare an elementary work on agriculture for rural districts that shall interest the child in the importance and necessities of this noble science.

The State of Missouri has adopted this course at her agricultural colleges. Short courses are given teachers of the public schools in agriculture and horticulture, and this new department is backed by the Governor, Superintendent of Public Instruction, state boards of agriculture and horticulture, and state industrial associations.

Oh! that we had apostles in these days with power to raise the dead—dead to the proper appreciation of scientific knowledge, who could demonstrate to them the great loss of energy in grappling with unknown conditions in every branch of husbandry, who could lift us to the higher levels of our calling, impress us with the truth that all civilization rests upon the broad base of agriculture, and that all other arts of science are her children, paint again "the man with the hoe" not with the stolid features of Markham's exaggeration but one radiant with the sentiment of Emerson "that all nobility rests in the use and possession of the soil."

At the conclusion of Mr. Smith's paper he called upon Mr. Miller, ex-President of the Oregon Agricultural College, for any suggestions as to how the evil could be overcome, and the agricultural colleges educate farmers instead of turning out lawyers, preachers, doctors, engineers, and everything but agriculturists.

Mr. Miller said it was because such schools were run by lawyers and politicians and not by or for farmers. This was the fault of the farmers. No people or no class of people could be raised up or their social condition improved by outside influences. The inspiration must come from within. Until farmers wake up and assert their rights they will have no rights.

# COMMERCIAL ORCHARDS.

By W. G. OFFNER, Walla Walla.

The shippers of Walla Walla would be dollars ahead if they had not shipped any cherries east for the last five years. Now it is not the fault of our cherries, for we raise as good cherries as anywhere, but the trouble is we are out of season. Now, when our cherries are on the market the people in the east have been eating California cherries for a month or more, and are somewhat tired of them. About the time ours are ready for market then come the Southern States with their peaches, and they come thick and fast, and soon get cheap, and the way we have to ship our cherries by fast train service at a high freight rate we have to get a good price for them to keep

even, and anything less than seventy-five cents or $1 a box in the eastern markets does not make us any money. Now, as I said, people have been eating cherries until they are tired of them, and when they can get peaches for twenty-five cents a basket they are not going to buy many cherries at $1 a box. This condition of affairs is what seems to be the trouble with our cherries in the eastern market, and I would advise planting something besides cherries for anything more than your local trade. As to apricots, I believe there is a fortune awaiting the man who gets a good location on the Snake or Columbia rivers and puts out a good, large, More-Park apricot orchard, and makes calculation to dry every one of them, as they are not a success shipped green. And I am told that they are a success, and they do grow to perfection on the Snake and Columbia rivers, even better than California's noted product. The pear I have had great hopes of as a money maker until the past two years. But the fire blight is blighting our hopes unless something can be done to stop it. This is especially so in the Walla Walla Valley. I have pulled out more than five hundred trees from four to eight years old this past year, and many of my neighbors have taken out as many more. I presume Dr. Blalock has taken out many more than this. It now looks as if a remedy is not found we will lose our entire ochard; and we are looking daily for some of those scientific gentlemen to discover something that will check it. I do not know to what extent it has damaged orchards in other sections, but it is a serious matter to the orchardists in Walla Walla Valley, and we have plans already to erect a monument to the memory of the man who finds a remedy. To those in districts free from this blight I would recommend the following varieties: The Bartlett has a world-wide reputation and cannot be side-tracked, but I think for eastern shipment there are others that will make more money, and that is what we are raising fruit for. The Bartlett comes in when it is very hot, and will not stand up long. If it has to be held for any time it goes down and, as many of us know, we often suffer a hard loss on them.

The Beure d'Anjou is a fine pear for local trade, but does not sell well in the east because it is not known. The same may be said of the Fall Butter. I have found the Glout Morceau is a better pear for eastern shipment than any other, as they are a late keeper and stand shipping well; and so far have proven a good seller. The Wintern Nellis does fairly well in Chicago and the western market, but does not sell well in the eastern market. There is a new pear, the "Comice," that is now selling for more money than any other pear. It is said to be superior in quality to the Bartlett, and a better shipper. I have some of the trees, but have never seen any of the fruit. Perhaps some of those gentlemen from the east may know something of it, and tell us if it has the good qualities that are claimed for it. If you have a good local market other varieties might suit your trade better, but for the eastern trade I would advise Bartlett, Comice, Beurre Easter, and Glout Morceau. Now, I suppose out of every thousand prune trees planted in the Northwest that nine hundred are Italian, as they seem to grow better and sell better than other varieties, and while we ship many of them east in a green state, the prune grower should depend on drying them, as it is treacherous shipping them green, as many of us can testify from our experience in

1898. But when properly dried I think they are as safe a crop to handle as any of the fruits we raise. We next come to the apple, the backbone of the fruit industry, which is grown and used more than all other fruits together. There are many families that never have a box of cherries, peaches or pears that think they cannot get along without their box or barrel of apples. And our markets are growing from year to year, and each year finds our apple being introduced in some new market. Now, the selection of the apple tree should, if possible, have more care than any other, for the reason that it is a longer lived tree, and it takes it longer to come into full bearing than most other trees. But with proper care it will be a profitable tree until it is twenty to thirty years old, and more in some cases. Now, it is generally thought that when trees get old the fruit is no good, and this is so in many cases. But if the apple tree is taken care of as it should be, and not let go unpruned and uncultivated as most orchards are, but is properly pruned, and well cultivated and sprayed, you will find the tree at twenty years old will give you from twenty to thirty boxes of as good apples as trees ten years old that will give you only from five to ten boxes. So it is easy to figure out the profit in properly taking care of your trees. Now, as to the varieties of apples it is hard to decide; many varieties have their friends. I know the old Ben Davis has many friends, and also many enemies, and if we judge the future by the past, we must admit it is a money-maker. But as for me I want none of it. And I know the people I deal with and sell apples to do not want it if it is possible to get anything else. If the foreign trade would take them they would be a good apple to raise, as they are prolific, a good keeper and a good shipper. And this is about all the good qualities they have. But the foreign trade does not want them. We all know the Newtown, Spitzenberg, Jonathan and Bellefleur; they sell in any market, and there are several other good apples, so why not raise them.

ADOPT VARIETY TO LOCALITY.

I admit all apples do not grow equally well in all localities. If you gentlemen at Yakima can grow the Spitzenberg better than other varieties, it is your apple to grow. If Oregon excels with the Newtown, grow them. Let us each try to find what does best in our locality, and then make the apple a success. We in Walla Walla think we can raise first-class Jonathan, Newtown and Bellefleur. The Spitzenberg does not succeed so well with us, and I do not think the Newtown does so well in the Palouse, as the season does not seem to be long enough for it. They should grow some apple that will mature earlier. I have at Walla Walla a twenty-acre orchard of winter apples that I have top-grafted to Duchess of Oldenburg and Gravenstein for the local market, as I find I can work off quite a number of cars of those early apples before the Palouse and Bitter Root apples come into market. This scheme is for the local trade only, and it would take but few acres to overstock it. Try to find out what does best, grow it and we will accomplish two things: get the best returns and not be in such competition with each other. I would not try to sell my poor Spitzenberg against the fine stock that Yakima and Oregon raise. The Palouse country would not be trying to sell its off-grade Newtowns against my good ones. If we are careful

enough and see that we get what is best suited to our locality, and then see that they are grown to perfection as far as care of the orchard will make them grow, we will in a short time be able to build up a trade in the foreign market that will use all the apples we can raise. We must reach out and secure that market for our apples or we will have to stop raising so many, as our orchards are assuming such proportions that our local markets cannot use them. A few years ago I shipped many cars of apples to Spokane, but that is a thing of the past. They are now heavy shippers themselves. Montana has been a great market for our valley, but contrary to the expectation of most every one, they too are raising quantities of apples, and claim in the near future they will produce enough apples to supply their market, and it behooves us to grow something we can ship to the Old World. Grow and pack as we can, we need have no fear of overproduction, for with the quality of our apples we will have a market for all we can raise as soon as we can get them established in those markets.

SPITZENBERGS WANTED.

The past season I had a letter from a dealer in New York asking me if I could get him a few cars of Spitzenbergs, but I had none to offer. In a few days he wrote and asked me to go to Yakima at his expense and see a car of Spitzenbergs that had been offered him at $1.50 a box f. o. b. Yakima, saying he did not know the party or his packing, and wanted me to see them. If all right he was willing to pay the price for them, besides my expense. He also said to buy all I could at that price if the stock was all right. We can sell apples if we have the right kind. Why not raise what people will buy at good prices? Apples of lower quality would not have been worth the freight to New York. I believe this is the fruit situation: Find out what our locality is best adapted to, confine ourselves to that, and push it to its highest state of perfection.

# FRUITGROWERS' ORGANIZATIONS AND ASSOCIATIONS.

By H. B. Miller, Eugene.

Whatever there is in the affairs of producers, as a class, that is disastrous, is due to an absence of organization in some form, and until we give up our prejudices against associations, and group ourselves together for our common good, we will remain sufferers, bearing the brunt of the burdens of society.

Someone asks, would you do away with competition? My answer is that competition is not all virtue any more than absolute monoply is a virtue. I believe that the evils of competition must be eliminated so as to have any social progress.

What is it then that interferes with the fruitgrower's success? It is undue competition amongst his fellows. Shippers, dealers, and commission houses knowing how to intensify this strong competition among growers, utilize it to beat down the price they pay, and where they can concentrate the fruit they put up the price to the consumer. By shipping fruit on commission the growers intensify the destructive influences of competition, and by shipping to the commission houses, a grower creates a condition where one lot of his fruit is competing against another lot, to see which can bring the lowest price. It is first to avoid all these ruinous disasters of competition that the grower must organize.

Individual competition lowers the general quality of any product, while organization invariably improves it. Where do you find the best quality of prunes, the best uniform standard that brings the highest price? At San Jose, where the strongest and best organization packs and markets. Where the finest quality of raisins? At Fresno, packed and marketed under the direction of the Raisin Growers' Association. The Ashland Fruitgrowers' Association improved the standard of their peaches the first year of this organization, so that association peaches were sought in preference to all others, and the prices were enhanced accordingly, and so it is everywhere, organizations have invariably improved the quality and standard of the product. Nearly all the evils of competition strike the fruitgrower in the market, and, is therefore important that the main scheme of his organization shall be to market his fruit.

The improvement of quality, the economy of concentration in marketing, the avoiding of the disastrous and demoralizing influences of crowding the market, the protection against destructive competition amongst growers, the assurance to the dealer that prices will be maintained are the main principles upon which organization stands and will succeed. It brings back to the grower the power he had to have a voice in fixing the price of his product before the strong and commanding powers of transportation and commerce grew up between him and the consumer.

Who has a better right to put the price upon the product than the man who raises it? He will see to it that the price is so fair and just that the consumer will use it.

Associations soon learn not to expect an unreasonable price for an inferior product. The individual may hope and endeavor to deceive a buyer, as the buyer hopes and endeavors to deceive him, while a successful organization stands by the brand on its goods.

While individualism and unrestrained competition fixes a low standard, and pulls the higher down to its level, co-operation sets a higher standard, and the weaker is improved and helped by the stronger. This is done as a matter of self-interest and is necessarily permanent. It gives equal returns for an equal product, but does not interfere with the rights or powers of the individual to profit by his superior skill or knowledge in the economies of production. It removes the evils of competition and retains its virtues. Co-operation through organization for marketing fruit makes a unit of that entire class of producers, and strives for the welfare of all of its members, and protects them against the evil influence of other organizations that would destroy them as individuals.

It is, of course, not feasible to follow the theory of annihilation of competition by substituting socialism. The practical thought is to subdue individual competition within the class that prevents improvement and development, and interferes with the creation of group formations necessary to industrial and social growth. Co-operation differs from socialism in that it makes a unit or group of those engaged in a given industry, but leaves this group free to adjust its interests and welfare to other groups and units in society. Socialism would destroy competition and make the state the industrial unit. It is, perhaps, only by contest between these various industrial groups that the proper adjustment of society and state will be evolved.

The monopoly of a group of producers does not mean that no one shall have the right to compete with them in the markets; it does not mean that law and government must be used to maintain a burden on society. The true monopoly of producers must mean first a maintenance of a fair and just standard of life for the members of the group. It must mean the highest class product produced under the most economical conditions as far as machinery, skill, knowledge and methods are concerned, but not by means which tend to cheapen man. It must mean such economy and skill in concentrating, handling, and distributing the products as to give society the best service with the least expenditure of energy. Its success stands upon the basis of giving the public the best product at the lowest cost compatible with maintaining a progressive standard of manhood for the producer.

A successful co-operation must not hope or expect state aid to maintain a monopoly, its monopoly must be sustained by its economic force in production and distribution; for the primary function of state is to protect the opportunity of all to engage in industrial enterprise, and it is the wise policy of monopoly to maintain such economy and skill in production and distribution and furnish the public its goods at such prices as makes it possible for competition to enter the field.

The state must lend its aid by means of protection, education, and cultivation to protect the standard of life to all classes of its citizens, and, to this end, we demand protection against cheap fruits, the product of cheap men. Cheap products, made cheap by making a cheap man, are not in line with progress in society. Cheap fruit at the expense of mortgages, deterioation in value of fruit farms, lowering the quality of the lives of producers, are demoralizing to society in general and bring a curse rather than blessing to humanity.

Association and organization to overcome the evils of individual competition seems to be the only method by which the welfare of producers can be secured and maintained.

# HORTICULTURE IN OREGON, AND FOREIGN FRUIT MARKETS.

Read before the Farmers' Congress at Salem, by HENRY E. DOSCH.

A paper on the topic assigned to me, "Horticulture in Oregon, and Foreign Fruit Markets," cannot possibly be written and compiled in a day or a week, and inasmuch as this is a composite congress of farmers, fruitgrowers, and commercial men, I hope you will pardon me if I present, in part at least, a paper I read at Corvallis, which in itself is a composite paper, along horticultural and commercial lines, being the resume of a correspondence covering over five hundred letters and six months' time.

## HORTICULTURE IN OREGON.

Oregon has earned the sobriquet of the Land of Red Apples from the earliest days of its settlement, to which we can conscientiously add the Fellenberg, now known to the trade as the "Oregon Prune." These fruits have since spread from our beautiful and fertile Willamette Valley, where both, on properly selected soils, will grow to perfection, to the uttermost boundaries of our state. The arid lands of the vast inland empire located along the flat areas of the Snake River, which were heretofore considered only fit to grow sagebrush and greasewood, the home of the jackrabbit and toad, have proved wonderfully fertile under irrigation and under the management of progressive, up-to-date farmers and fruitgrowers; and in the near future I predict these lands will be the home of winter pears and apples.

The beautiful Grande Ronde and other valleys, scattered throughout the higher plateau region and Blue Mountains, as well as Hood River along the Columbia River, and which do not depend upon irrigation, are most fertile spots for the fruitgrower — perhaps nowhere do apples, pears, cherries, and prunes grow to greater perfection as to size, flavor and color. And again, there is Southern Oregon with its Rogue River, Umpqua, and other smaller valleys, offering peculiar advantage to horticulture, which at no distant day will be a veritable paradise for the fruitgrower. The climate there is unsurpassed anywhere in this fair land of ours, and there flourish the peach, apple, prune, French walnut, almond, and grape.

Horticulture is no longer an experiment in Oregon. The incessant drudgery, the numerous and keen disappointments which are peculiar to all new enterprises, and from which Oregon did not escape, are things of the past. We have reached the era of scientific management of the orchard. Horticulture, as we understand it, is no longer the problem it was, thanks to the scientific investigations of the professors of the experiment stations throughout the world, and to practical fruitgrowers. We know the soils best adapted for various fruits, the best varieties to plant for family use or commercial purposes, and know how to evaporate them. We also know

what varieties to plant together for pollinating purposes. We know the diseases and insects infesting trees and fruits, and how to combat them, but the marketing of our products to advantage is the greatest problem that confronts us today, and this brings us to

### FOREIGN MARKETS.

"The great secret of success in life, is to be ready when the opportunity comes."—*Lord Beaconsfield.*

The subject of markets is perhaps the most serious problem confronting the fruitgrower, and when we look over the large area that has been planted to fruit, and is still being planted throughout the fruit districts of the United States and Canada, we cannot help speculating what to do with all these fruits, especially in a good fruit year.

There is perhaps no fruit which is more universally planted at this time than the apple, owing to the fact that the apple is par excellence the commercial fruit of the world. Millions of trees are being planted yearly, and if it were not for for the fact that winter apples are grown comparatively as yet in few localities, the result would be appalling. Even as it is, our home markets are now fully supplied, and in a short time will be glutted. There is but one solution to this problem, and that is, to seek foreign markets.

My attention was first drawn to this matter about eight years ago, when the Chamber of Commerce of Portland honored me as a delegate to the Nicaragua Canal Convention, which was held in New Orleans in November, 1892; and there, in conversation with representatives from the South American republics, I learned that there would be a good market for northern-grown fruits, if freight rates could be arranged. Again, my attention was called to it in a letter I received from the consul in Manchester, England, three years ago, stating that a lot of Rogue River apples had found their way there, and that finer apples were never seen, and buyers wanted to contract for the entire output of this man's crop, which was four thousand boxes in 1898, and all were shipped to that point. In this connection the *New York Journal of Commerce* says: "A large increase in the shipment of Pacific Coast apples abroad by way of New York this year (1898) is a noteworthy feature of the fruit trade, and is exciting no little interest; large quantities of Newtown Pippins in boxes weighing fifty pounds net, grown on the Pacific Coast, principally in Oregon and California, have been sent to this city of late, in carload lots, and from New York have been sent directly abroad. Some handsome Newtown Pippins passed through New York lately from Oregon." But it is not England alone, there is a growing market in Germany and France for our fruit. My advices from the consuls and dealers are very enthusiastic and encouraging. Mr. Cunningham, Consul at Chemnitz, Germany, a large manufacturing center, writes to me: "I wish I had time to detail to you the desires of the people here for our fruits. Germans hunger for our fruits—apples before all others, etc. In France we have a promising market for our fine Italian prunes, and for apple "chops." Mr. Joseph I. Brittain, Consul at Nantes, France, writes to me: "There is a good opening for evaporated apples known as 'Chops.' These apples, which are the lowest

grades of windfalls, are sliced thin and dried, including skins, seeds and cores — and inhabitants. They are packed in plain barrels. The poorer classes here use large quantities of these apples for making an apple wine known as 'Piquette.' Last season one firm imported twelve thousand barrels of apple chops, at a cost of seven cents per pound." Mr. Albion W. Tourgee, Consul at Bordeaux, France, says in this connection, that in 1897 thirty-five million gallons of this piquette were used, which increased to fifty million gallons in 1898: and as it takes one pound of chops to one gallon of piquette, it means fifty million pounds of apple chops. And so are all other reports of foreign states, many stating that instead of exporting, as heretofore, they would have to import more and more each season.

Latest advices from Berlin say: "In view of the circular sent by the German government to the chambers of commerce and other bodies, inquiring as to the desirability of a duty on fruit, the Society of Hamburg Fruit Dealers has adopted a resolution declaring emphatically that American fruit is indispensable there, and protesting energetically against a duty." But owing to the high freight and refrigerator charges from the Pacific Coast to the Atlantic seaboard, we of the Pacific Northwest are somewhat handicapped in European markets, which, however, is offset by our superior fruits and the higher prices they command in these markets, especially England. Prices for apples ranged this fall as follows:

| *Variety.* | *London Market.* | *Hamburg Market.* |
|---|---|---|
| Baldwins | 12–16 shillings per bbl. | 13–21 marks per bbl. |
| Ben Davis | 12–15 shillings per bbl. | 9–18 marks per bbl. |
| Winesaps | 11–13 shillings per bbl. | 10–12 marks per bbl. |
| York Imperial | 16–18 shillings per bbl. | 16–17 marks per bbl. |
| Kings | 15–19 shillings per bbl. | 15–17 marks per bbl. |
| Northern Spy | 13–14 shillings per bbl. | 17–19 marks per bbl. |
| Spitzenbergs | 13–14 shillings per bbl. | 10–14 marks per bbl. |

Now please note: Pacific Coast Newtowns, eleven shillings per box, equal to thirty-three shillings ber barrel, more than double the prices realized for eastern apples.

These figures will also form some guide to intending planters of apple orchards, as well as to shippers. The total shipment this fall, up to December 1, was sixty-eight thousand nine hundred and twenty barrels.

PRUNES IN GERMANY.

| *Size.* | *Italian prunes.* | *Processed French prunes.* |
|---|---|---|
| 30's to 40's | 18 to 20 cents | 14¼ cents. |
| 40's to 50's | 15 to 17 cents | 12 cents. |

In France the prices range from sixteen to twenty cents. Small-sized prunes should not be sent, as they come into competion with the home-grown goods. But we have a market which is practically our own. When I became convinced that the Pacific Northwest would soon grow more apples than

could be used at home, as well as prunes, I put myself in communication with the consuls of Europe. China, and Japan, regarding the possibility of exporting some of our fruits to these respective countries, and have received hundreds of encouraging replies, and it affords me great pleasure to state that I received the first cash order for a lot of apples from Nagasaki, Japan, which has been filled by one of our dealers. This oriental market is the one for us to operate in. It is a field of such importance that it should be taken in hand at once; its possibilities are so vast that the end cannot now be seen.

Recent statistics show the exportation of fruits in 1898 to oriental markets to have been about as follows (the 1899 reports are not yet available), viz.: British East Indies, $12,346; British Australasia, $260,611; other Asiatic possessions and Oceanica, $147,151; Hong Kong, $67,718; other parts of China, $23,761; Japan, $22,713; exports of preserved food, including fruit from Spain to the Philippines, $175,261; wine, $148,816; flour, $149,940. Here are markets which should be, in fact must be, cultivated and developed, and they are practically our own, especially for our fine apples and Italian prunes. The evaporated product of this prune is too fine to bring into competion with sun-dried French prunes, as is done now in our eastern markets. This competition would be eliminated in the Orient, as the inhabitants of that climate demand a semi-tart fruit, a quality not possessed by the sweet, insipid, sun-dried French prune of California. Therefore this market belongs exclusively to the Pacific Northwest. But, in catering to this market, we must prepare our fruits in the way they want them, and not in the way in which we would like to have them taken. At the risk of repeating myself, and only for the important matter contained therein, allow me once more to quote from the reply to my letter of inquiry, addressed to Mr. Johnson, Consul at Amoy, Japan: "There is a steady, increasing demand among the natives for foreign fruits, whether canned, dried, or preserved. The European population look to these imported fruits almost exclusively to supply their tables. Tinned pears, peaches, and apricots come principally from America, while preserved fruits, jams, and dried fruits still come largely from Europe. The reason is apparent: The American manufacturer will not, or does not, meet the conditions required. Since there are no peaches or pears in Europe which can compete with those of California, the oriental merchant has no choice; in other lines he is not so restricted. Prunes and raisins are largely used. The dried fruit is put up in bottles and sealed. In no other way can it be shipped to the tropics without great loss, as the humidity of the climate, or insects, will soon render it unsalable. No fruit, biscuits, crackers, or other food products can be safely shipped to Central or Southern China, Japan, or Philipines, without being sealed in glass bottles or tinned. The English and Continental merchants and manufacturers understand this, and put up their fruits accordingly. If tinned, the tins are either painted or varnished to prevent rust and consequent loss to merchants. The American manufacturer has found a market for his product without these extra expenses, and is slow to meet this demand, hence dried fruits, jams, and tinned fruits are usually bought in other countries where these necessary details are looked after. If our exporters of fruit

expect to hold the market in the Philippines, or to gain a better footing in China or Japan, they should begin by studying the conditions and promptly meeting them. Prices realized in China and Japan for fruit justify the expense necessary to put them up so as to insure their being in good condition when they reach the consumer."

This is a decidedly plain statement of the condition, and we should not fail to grasp the situation.

In the line of apples it becomes necessary to grow such varieties as will stand ocean transportation. A hard apple is what the trade demands, however much of this question will be solved by shipping in cold storage. Meats have been transported in cold storage steamers, through all climes, to every land, especially from Australia to England, and so will be our fresh fruit; with the completion of the Nicaragua Canal, tramp steamers which are now traveling our seas in every direction, seeking cargoes from anywhere to anywhere, will crowd our docks, eager to carry our surplus fresh fruits to the markets of the world, and competition will make freights low enough to allow a good margin to the grower.

At a banquet given recently at the Waldorf-Astor by the New England Society of New York, the Hon. John Barrett, ex-minister to Siam, than whom no man is better qualified to speak on this subject, responded to the toast "The New Pacific," and said in part:

"The Orient wants the flower and fruit of the Pacific Coast. * * * The lusty commonwealths of California, Oregon and Washington, looking out on the New Pacific, realizing that through its commerce they will attain the importance, wealth and population for which their location has designed them."

Hon. D. P. Thompson said to me some time ago: "I just received some letters from Tokio, Japan, from friends to whom I had sent a few boxes of evaporated Italian prunes for a present. They write me that nothing of the kind could be had there for love or money, and expressed a surprise that if we had plenty of such fine fruit, why we did not ship it there, as there was practically an unlimited market for it."

All these are markets of great importance, and as I have said before, should and must be cultivated, and as we shall have little or no competition, they are practically our own. I am firmly convinced that in these districts alone is a field for operation that will absorb all the surplus fruits raised in the Pacific Northwest, and that there is a market not only for our fresh, canned, and evaporated fruits, but for everything else we have for sale and can supply these markets with. But in reaching out for these foreign markets we must concentrate our strength, ship only first-class fruits, for poor grades come into competition with the home-grown fruits, and in consequence meet with poor or no sales.

Permit me to quote from a report of United States Consul-General Mason, stationed at Berlin, Germany. In reply to the question, "Is there any complaint as to dishonest packing or grading of dried fruits from the United States, and what needs yet to be done to improve the trade, and render it stable and permanent?" he says:

"There has been to my knowledge more or less complaint in regard to packing and assorting of American dried fruits. I never have investigated a case of this kind in which the complaint did not prove to be fully sustained. I examined yesterday the first box of dried apricots from this season's crop, which just arrived from one of the foremost packing firms of California, a house whose brand on the packing case usually is accepted as a guarantee of quality. On removing the lid the fruit appeared in neatly-arranged layers, the pieces large, firm, and uniform size and color: the dried flesh as translucent as gelatine, and of fine aromatic flavor.

"The box being turned over and the bottom removed, a wholly different picture was revealed. There the fruit had been loosely thrown in in pieces of all sizes, mainly small, irregular in shape, and of all shades of color, from the golden brown to deep mahogany, many pieces showing by their form that they had been saved from apricots which had been partially decayed. All these were good enough to be eaten, but were not what the buyer ordered and paid for, nor what the seller pretended to sell, and, as the disappointed importer somewhat bitterly remarked, 'If this is what we get from a first-class exporter, who puts up his own fruit, what may we expect from jobbers who gather up and export the miscellaneous products of small packers and individual farmers?'"

This covers the case completely, and what is true of the apricots is also true of the prunes. If we wish to capture these foreign markets then our fruit must be honestly graded, honestly packed, and honestly labeled. To do otherwise is commercial suicide.

# EARLY HORTICULTURE IN OREGON.

By JOHN MINTO, Salem.

As potatoes and peas were the first things planted, one year in advance of the seed of wheat, oats, barley, and maize, received from Hudson's Bay, it is safe to assume that the cultivation of vegetables received attention prior to or simultaneously with that of grain for breadstuffs by settlers as well as at Fort Vancouver, and as the garden precedes the field, in natural order, we have reason to believe that the most intelligent Canadian trappers, like Gervais and Luceir, began in the same order. We have this evidence that the garden preceded the field in their case, as it was most suitable as a means of experiment with one quart of wheat which Doctor McLoughlin gave Mr. Luceir to begin with. In the case of Mr. Gervais, we have the testimony of Daniel Lee's letter, that the garden was the most notable portion of his improvements; as, to do the arrival of the missionaries, in 1834, special honor as his guests, he stretched a tent and placed beds, and they "slept in a garden of cucumbers and melons."

Human love, in its earliest movements, expresses itself with flowers, and the felicities of success are expressed with fine fruits. It is but natural, then, that we find among the first most important body of home-builders of 1843, those who not only brought garden seeds, but attempted to bring growing plants of choice fruit. J. M. Garrison started with some grafted apple trees but failed to get them through. In 1847, R. C. Geer bought a peck of apple seeds and about half as much pear seeds. But, as illustrative of the greater efficiency of the most advanced frontiersman to best meet the wants of a further advance, we have the grand action of Henderson Luelling, starting from Iowa the same year with a very complete nursery of growing fruit trees and succeeding in getting them to Oregon. The enterprise of these two men naturally supported each other, and their mutual dealings amounted to thousands of dollars; as Mr. Geer subsequently received larger quantities of tree seeds from Ohio, and scions of particular kinds of fruit he had shipped to him, in sealed cases, around Cape Horn. Later, Judge Cyrus Olney brought several bushels of apple and pear seeds and planted in the campus of the Willamette University, and after the wonderful enterprise of Mr. Luelling a Mr. Ladd brought a nursery of fruit trees via the Isthmus of Panama, from Ohio. These, however, were the conspicuous horticultural enterprises. Less definable sources were by almost every family bringing the seed of some favorite garden or orchard product. It is not known whether the first missionaries of the Methodist Episcopal Board of Missions brought any seeds or plants, but as their purposes included an industrial school for the natives, it is presumed they did.

The writer, who was the first resident owner upon the site, and in the first building erected at Walamet, and selling the right after four months of ownership, reserved and took to his chosen location for a home the horticultural plants deemed removable, of which the rosebush, since extensively designated as the "Mission Rose," and the rhubarb, currant, and gooseberry plants were the most important. There was then only left some six or eight peach trees, not less than eight or nine years old. There must have been some apple trees of the same age which were moved to the new location, as I saw trees on the campus of the "Oregon Institute" evidently too old to have been grown there within the time since the Mission was abandoned.

The foregoing indicates how the earliest homebuilders began. One family brought peach pits and plums, another cherries, another apples and pears, planted them and generously divided with others when they had to spare. Others marked and transplanted wild fruits. In this way the wild currant and choke cherry of Eastern Oregon, and wild plum and grape of Southern Oregon, were brought to, and planted in, the Willamette Valley in 1848; and the native Blackcap raspberry was transplanted to gardens before the discovery of gold in California. This brought the fact to the attention of the people of Oregon that Henderson Luelling, by his wagon load of choice varieties of fruit trees, had brought a magazine of wealth within reach of the farmers of Oregon.

With the money results of the first sales of produce to the California miners orders went East for books and periodicals. Fruits, such as the seedling apples from the Gervais and Lataurette orchards, and peaches

from Rev. E. A. Parrish's, were eagerly bought at $3 per bushel, the seeds so secured being the most prized part of the purchase. It seemed in the nature of a special providence that Mr. Luelling's venture and intelligent care began to produce specimens in 1849. Families who had beds of seedling apples readily sold all they would spare. These were transplanted with care and head-grafted, so that no time was lost. Where wild stock could be used, as the native thorn for the pear, or the crab for the apple, they were sometimes used with excellent results. Yearling or two-year-old nursery trees of choice varieties of apples were eagerly bought at fifty cents to $1 per plant, and prunings of the roots and branches or shoots used by the root-grafting process to make several more trees without perceptible injury to the purchase. So with pears, for which $2 per plant was freely paid, when the bud giving its chief value was yet a bud only.

Prices for the first fruit sold in California amply justified these prices for nursery trees, as, if a man and woman were passing Luelling's retail fruit stand in San Francisco at any time between 1849 to 1859, and the lady looked interested at the beautiful specimens, she got her choice without regard to cost. Five dollars was sometimes paid for a single apple, and as late as 1856 Esopus Spitzenbergs, of average size, retailed from the stand at seventy-five cents each.

The writer sold his first crop of apples and pears on the trees at fourteen cents per pound. The purchaser picked them, packed them in light boxes with moss, and hauled to the mining camps of Northern California, selling such pears as the Seckle at $4 per pound. His second and third year's crops were picked without bruising, packed in boxes of forty-five pounds each, and hauled by wagon to Portland, selling at twelve and ten cents per pound in 1854 and 1855 respectively.

These prices, of course, stimulated great care and devotion to fruit culture, and in addition to its being a new field of observation and interested labor, there was a very general belief that we would always have the California market—that the climate of that state would never admit of the successful culture of apples, pears, plums and cherries. There were few natural enemies to perfect fruit production, and more blemishes from sun scald than any other climatic cause. But by 1856 orchard planting began in California. Foothill lands and those near the rivers being at first selected for the fruits I have mentioned: and even before these orchards began to bear, the rapid increase of Oregon's product began to lessen prices in California. Then, other fruits sought the golden market, and as early as 1856 monstrous fruits of the pear kind from Japan were in San Francisco markets. The Japanese pears had more the flavor of an indifferent turnip than of such fruit as the Bartlett pear. In ten years from 1850 apples and pears in the California market were not selling at much, if any, more profit on the labor of production than wheat farming would give, so that it was wise counsel the *Oregonian* gave Oregon farmers when it urged the expansion of wheat fields, so as to get into the world's markets with breadstuffs. Extensive orchards began to be neglected when not situated convenient to local market, or in the ownership of those who were fruitgrowers from love of the occupation, and pursued it, profit or no profit. Some, like the writer, kept on as long as choice cider

could be sold, but the market for apples in that form was only local, and as we had reached the point of no market, many orchards were suffered to become stock lots, and unfortunately left for fifteen to twenty years to become the nurseries and breeding ground for every insect that preys upon neglected fruit and fruit trees. These, where alive and still neglected, ought either to receive thorough pruning, cleansing, manuring and general care, or should be grubbed up and consumed by fire, root and branch. The latter, as a rule, would be best economy.

The use of good fruit has, from the changing habits of society, become an important product in all markets, so that many land owners of limited acreage can make fruitgrowing a reliable as well as delightful occupation. I am not in favor of anyone making fruitgrowing a sole dependence. Ten acres I consider large enough for a family orchard, but I would always wish such a family to have ten acres more, so that butter, milk, eggs and poultry could be produced, and a light team kept. On this second ten acres, nut-bearing trees could and should be planted—the kinds planted selected for their value as wood whenever possible.

## FOREST INTEREST.

The people of Oregon are blest with forest resources of immense value, of which (while they are waiting for the lumber demand which is surely coming), they can not be too careful to protect from fire—money spent that is as wisely invested as in the protection of city property. The home market for lumber in the United States has never paid for the use of the land on which the trees grew. The quantity of land in states like those of New England, New York, New Jersey, New Hampshire, Michigan and Wisconsin which is left to these respective states by owners rather than pay taxes on it after the timber of God's planting has been cut off, is proof that up to this time there has been no income from the land on which the trees grew: and only where they have been cut and taken to market by most economical methods, has there been encouraging profit in that business. Over half of the area of Western Oregon is yet in forest or wood land, the timber on which has averaged one hundred years of growth. The most recent estimate is nine thousand feet, board measure, per acre on wood land. Cut it today and put it into the world's markets by the most economical methods known, and, after paying cost for labor and encouraging profit for capital used, tell me, who can, how much would be left to pay taxes on that land at present rates on $2.50 valuation?

The writer and his wife were recipients of three hundred and twenty acres each as pioneers to Oregon. Their chosen locations did not contain three acres of timber of size small enough for building purposes. It was beautiful land for stock-growing purposes. We thought we would have to plant tree seeds. Grass fires stopped in 1846, and in 1850 young firs of nature's sowing began to show above the grass on the broken lands. There is now thirty or more acres of timber from forty to fifty years' growth. Two years ago my wife sold the wood growing on eight acres of the oldest by the cord, and realized $200 for the wood grown on eight acres in forty-eight

years. At a rough estimate, it requires the expenditure of that sum to put that lot into the best pasture grasses.

Thirty years ago the writer, desiring better grass land than his donation claim, purchased a body of alluvial soil adjoining Salem. It had been taken as a donation claim in 1850, and its wealth of timber growth taken off for lumber and cordwood during twenty years. In that period it passed through seven different ownerships, yet was under mortgage for its full value at the time of my purchase. Less than three acres of it was clear enough for the more profitable use of potato growing. Laying between the low-water mark of the Willamette River and twenty-five feet above that, nothing but constant use for richest field crops will prevent nature from covering it with trees and brush woods,—for water is the nursing mother of trees. After twenty years cutting of sawlogs and cordwood there was still mature ash and balm timber unculled. Taking the market price, $33 was received for mature ash logs and $130 for balm or water poplar for paper pulp. This $163 would not have paid for clearing the land of stumps and brush woods; immediately the fire, axe, and grubbing-hoe, grass seed, cattle, and sheep were freely used to kill the unprofitable undergrowth of blackberry and salmon berry. It was found that the immense balm trees too large for paper pulp log contractors to handle while alive, and acting as pumps in taking the moisture from the soil lower than the roots of cultivated crops would reach, rendered even the culture of potatoes profitless within the radius of their live roots, and such trees have been either cut and floated off on winter floods or girded, dried, and burned as they stood. On land yet incumbered with these large stumps, four hundred bushels of potatoes per acre was harvested in 1899, and from thirteen acres, two thousand sacks have been taken this season of 1900.

On the lowest land producing trees field crops are rendered unprofitable by live tree roots taking the soil moisture—these killed—and corn, white, red, and alsike clover, blue and perennial rye grass, redtop and barnyard millet, grow down to the lowest plowable land.

On the highest of this land from low-water mark suitable for intensified farming with any crops of fruits, grasses, or grains are grown. Twenty-two and one-half acres in hops have aggregated a cash return for the past four seasons, 1897 to 1900, inclusive, of $12,050.26. These results are not cited because they are any way near what more thought, more labor, and skill in culture can produce; but as a means of illustrating the proportion of family life sustainable from twenty-two and one-half acres of this land as compared with the value of its product as natural forest, —believing as I do that in all probability $12,000 is as much as wood product of the entire tract of two hundred and fifteen acres has returned to its owners in the twenty years preceding the present ownership—as much as it would sell for today in paper pulp material if it stood as the untouched forest growth for one hundred years. I do not mean by this to advise neglect of timber culture. Far from it. I am a lover of trees.

TREES AND THEIR INFLUENCES—SILVIA CULTURE AS A DUTY.

The writer has no hesitation in confessing that he owes much of happiness of a long life to the influence of trees, both as massed in woodlands and forests, and to individual trees of particular beauty, strength, or grandure of dimensions. A well-grown fruit tree, in full bloom or laden with ripe, lucious fruit, is a joy to contemplate. A fine oak or other great forest tree, impells the dullest mind to dwell on creative power and to "look through nature up to nature's God," and so warrants the poet in saying:

"The groves were heaven's first temples."

Starting from beneath the trees, which are natural shelter from the cold of winter or heat of summer, the natural man must have early in the world's age reasoned upward to the beneficient power we call "God." So that man now, when his inventions have taken him far from the wild, natural life, cannot frame the story of his own evolution in a manner more probable than that of the story of Eden—the garden consisting of every herb and tree-bearing fruit—yielding seed—"pleasant to the sight and good for food," into which man was put "to dress it and to keep it."

It is highly probable that there was not on the face of the earth a district so extended, carrying trees of so great variety, suitable for the highest uses of man, as North America was at the time of the landing of the Pilgrim Fathers at Plymouth Rock. The native energy of those immigrants, and the natural nursery of further development of energy they found in the climate and other conditions to which they came, made them destroyers of living timber of necessity, in order to clear land from which to raise food. After that, to convert the living trees into merchandise, as logs, structural timbers, plank, and the finer manufactures of wood, was a natural evolution of economics, hastened in development by the mother country's policy of prohibiting the founding of other lines of manufacturing industry in her colonies already established in England—a market for the products of which the American colonies were long held by the mother land. Yet, adding to land-clearing and sales of wood in various forms, including the arrow-marked kings trees of colonial days, and destroying it by great labor in many ways, it has taken the industries of the Atlantic seaboard states over two hundred and fifty years to note they may have overcut their timber lands. Happily, this perception has not come too late. Intelligence and public spirit has begun work, and many of the highest schools have taken up the teaching of forest management and silvia culture.

Under the leadership of a comparatively few enthusiastic lovers of trees, however, the American Forestry Association has reached out beyond these overcut localities, and induced the adoption of a forest reserve policy by the national government, on grounds of questionable policy, in withdrawing the public lands from private ownership. The wisdom of sufficient forest preservation and care for the future is not only undeniable as good policy, but believed by the writer to be a high duty of the citizens of every state.

I believe the people can be trusted. On almost every area of one hundred and sixty acres in every portion of the United States on which falls an

annual average of thirty inches or more of rain, or its equivalent of snow, there are spaces more fitted for timber trees than for any other product, and these should be kept as woodlots, producing woods of the greatest value the situation for soil moisture will successfully grow. Take the land I have been describing. From the level of five feet above the low-water mark of the river even low meadow grasses like redtop, barnyard millet and alsike clover, the native ash, balm (water poplar), and wilow will grow down to within two feet of low water. The owner leaves about thirty acres in timber, the ash, not using one-quarter the area, being deemed quadruple the value of the other woods combined; but any spaces from the five-foot level upward, such as permanent fence lines and the like, are utilized for the production of furniture woods—nut-bearing kinds, like black walnut, pecan, and hickory, being preferred. In this way the very waste portions of the farm can and ought to be made produce the most valuable wood and shelters for domestic stock and game, also a delight to the eye of owner or passer-by. This last may be deemed a far-fetched consideration, but those who have traveled in a treeless land, as western Nebraska, much of Illinois and Iowa were fifty years ago, and much of the main Columbia Valley was twenty years ago, know how much better than "a great rock in a weary land" is the little clump of fruit and shade trees with which the home-builders in a treeless country hasten to surround themselves. Wherever soil moisture sufficient, secured from ditch or well, can be conserved—in which the house itself is often the best agent—a few trees can be and should be grown.

While speaking thus earnestly for tree planting in land fit for trees only, and for use and beauty in other places, the writer is no believer in any cause for a timber famine. I have given a few practical illustrations that present and past prices for lumber in the United States have paid no rent or profit on the land on which the timber grew, and not always fair wages for cutting it off and marketing. We have passed the wooden age in the United States, and from the warship Oregon down to sidewalks of streets, steel, nickel, platinum, and concrete cement, are better for defense, home use and health, than wood; for many uses more economical.

Nor am I writing as a forest faddist, pretending to believe the tree to be the mother of the fountain. My observation tells me all trees and plants are consumers of water, and part with it by evaporation into the air, to float off we know not where, to condense and fall as dew, rain, hail or snow; we can not know on what. Nor can I believe from any information I yet possess that it is necessary or the best wisdom for our national government to guard our forest interests against its citizens. I am in favor of expansion of national power over new wild lands, but also favor the expansion of the national freedom citizenship in its organized states. The citizens of Western Oregon are capable of marketing the vast timber wealth from the forest portion of our state, and for twenty-five years past a state officer, authorized to permit the taking of timber for buildings, fences, and fuel from the wooded lands of the Blue Mountains, would have been a blessing to pioneer grain farmers of Eastern Oregon, and would now.

# A DEAR SCHOOL.

A TRIFLING CIRCUMSTANCE AND ITS RESULTS.

By Dr. J. R. CARDWELL, Portland.

It was in August, 1853, in the little village of Portland, we met our first surprise in the fruit product of Oregon. A small basket of peach-plums had attracted a crowd of fruit-hungry admirers. They were handed out, five for a quarter, the smallest change offered or accepted in pioneer days.

Today you cannot understand the sensation of this occasion, or how, later, the first boxes of Italian prunes on a country wagon collected a crowd of merchants, clerks, and street people to the marketing, and how voraciously they were eaten out of hand on the spot. The price, though extravagant, was not considered. You cannot understand, for you were never young, a thousand miles away from home, in a new country, isolated, without transportation, and without fruit. The peach-plums referred to were highly colored, large, and beautiful, as we know them in Oregon, but then they looked much larger and more beautiful, the aroma was most appetizing, and the melting, juicy pulp of the ripened fruit was enjoyed with a keen gustatory satisfaction.

In our distant home in the west, then as far out as Illinois, we only knew the little wild red plum, stung by the curculio, and wormy. We boys ate them at the risk of the worms, which we no doubt often ate with the plum. The cultivated domestic plum had not been introduced: we had never seen it, scarcely heard of it, hence the surprise.

Citizen P. W. Gillette, yet with us, was then a nurseryman, near Astoria, and had imported from his father's nursery in Ohio a fine stock of fruits and ornamentals. It was in 1855 I made my first considerable order, and I have been ordering and setting trees ever since, as I have been told I "had the tree-setting craze, and had it bad." In the sober reflections of the present I must acknowledge it was true. I had to set trees. For many years I cleared our heavy timber land, and set out ten acres a year. Moderately speaking, I have set over two hundred acres in trees—not a large orchard now. The time had not come for the large commercial orchards of today. My friends tell me I have the honor, if honor it be—questionable—of setting the first commercial prune orchard on the coast.

I was not alone: the mania was infectious: seemingly nearly everybody was setting fruit trees and plums; the front yards and the back yards had them. Much shrewder business men set orchards to plums—Meek & Lewelling, George Walling, Seth Lewelling, and others; later, P. F. Bradford, Doctor Plummer, S. A. Clark, Dr. Blalock, and a multitude of orchardists.

It was not until 1871 I put out twelve hundred peach-plum trees. There was then a great demand for large-pitted plums in the eastern market, and our grocerymen called for them in considerable quantities at home, and often

said to me, "Set out pitting plums, and peach-plums, and don't set anything you cannot pit, for the American people don't want a prune with the pit in it. They don't like them. A few of our large-pitted plums had reached the Saint Louis market, and were selling readily at thirty-five cents per pound. We figured two hundred pounds to the tree, then thought to be a conservative estimate, one hundred and sixty trees to the acre, and forty acres in plums, at fiften cents a pound, dried. This was good, better than a quartz mine; divided by two, it seemed good enough. Time passed. Market reports east showed active demand for pitted plums. Leading wholesale grocers ordered, and said we need not fear an oversupply of plums as per sample sent, and that there was nothing so fine in the market. We sold at sixteen cents per pound, and were assured they could not drop much below that price.

A correspondent, a grower, Mr. S. J. Brandon, of New York, had discovered, or thought he had, that a heavy clay soil, very like our hilled lands, was unfavorable to the curculio, the blighting pest of the east that had discouraged plum and prune growing in all the states east of the Rockies. Mr. Brandon, however, was growing successfully a forty-acre orchard of Reine Claude plums on heavy clay land in New York State, and was reaping a golden harvest from the green product in New York City market.

Another correspondent, Prof. C. V. Riley, then state entomologist of Missouri, afterwards government entomologist at Washigton, had written me that the curculio did her work at night, and only when the thermometer was above 75° F.; lower, she was chilled and could not work.

As our nights are uniformly below that temperature, I concluded, and yet think correctly, we should not be troubled with that pest, the one pest that had discouraged the growing of plums and prunes in the east.

Set one thousand Italian prunes, and with the idea of filling in the drying season from the early peach-plum to the Italian prune, successively, for some years I set out the following varieties: Five hundred late peach-plums, five hundred Washington, five hundred Jefferson, five hundred Columbia, five hundred Pond's, five hundred Reine Claude, fifteen hundred French prunes, twelve hundred Coe's Golden Drop; cultivated — plowed twice, hoed around trees twice, harrowed four times, and finished with clod-crusher and leveler, made of six-inch fir poles, five pieces six feet long, spaced six inches apart, 2x4 scantling spiked to ends, which has to this time proven the best implement for this purpose, and seems to me almost indispensable as a finishing tool in cultivating our clay hill soil.

The winter of 1878 was cold, the thermometer falling to five degrees below zero, with stormy northeast winds for weeks, ending with a heavy snow storm. The cambium wood froze and turned dark, almost black, the bark burst loose almost entirely on many trees, particularly the peach-plums. Over in Clark County, Washington, and about Portland we thought our trees were killed; yet, in the spring, to our surprise, they nearly all grew and seemed not injured, excepting on the southwest the bark of the peach-plum died, as we judged, on account of the warm 2 o'clock sun while the trees were yet frozen. In a few years the damage was scarcely noticed.

The first year of bearing I sent two carloads of peach-plums, wrapped in

papers and carefully packed in twenty-pound boxes, to the Chicago market. The weather was warm in transit, they were delayed, and arrived in bad condition, and were sold for about the freight bill, commission, and other charges. I made other ventures of this kind and learned in the dear school of experience that the peach-plum did not carry well, and could not be profitably shipped so far east. Our commission merchants tried many such experiments, and I do not know that anyone ever made anything shipping peach-plums east, and I do know there were many losses, and the business was abandoned.

Early in the seventy's I built the Acme Fruit Evaporator, bought a Lilly pitter, which, by the way, pitted three thousand five hundred pounds in ten hours, and, after the failure of my shipping scheme, dried the entire product of my orchard. For some years, starting at sixteen cents per pound, the business paid nicely, then prices dropped to fourteen, twelve, ten, and down, until 1890 they were a drug in the market at six cents, unsalable, and were held over, some for three years, and were then reprocessed and sold at a loss. The fashion had changed, the fad was off, people were tired of pitted plums, the trade turned to prunes, the call now was for prunes with the pit in, as it was claimed to give the true prune taste, which the pit alone could do. This was disastrous. What should I do with my plum orchard? Here was a condition serious. I was theorizing: "Was it possible to graft new heads on these trees successfully?" This was questioned; orchardists shook their heads and thought it too big an undertaking. Some advised digging up the trees to set prunes. I was selling prunes at twelve and one-half cents per pound in fifty-pound boxes, faced. Our Italian prunes led the market, and were readily salable at that figure. This was paying fairly well; a legitimate business, so to speak. We were then possessed of the idea that we had a little neck of the woods in Western Oregon and Washington—the only spot in this great continent that could grow successfully the Italian prune. We were led to think this as they had failed in California, the east, and other localities, and, presumably, they required a heavy clay soil, and a cool, damp climate, and we didn't know of any other such country, and we were growing them successfully, and we had the verdict of the markets and all comers to that effect.

In 1871 I secured an experienced top-grafter, started in April and grafted twelve hundred twenty-year-old peach-plums into the Italian prune, putting ten to thirty grafts in a tree. It looked destructive. Orchardists looked wise and said it was an experiment; some thought it would not succeed. I had tried a few trees the year before with my own hands, and was hopeful. It did succeed. Fully ninety-five per cent. of the grafts grew; enough so that no further grafting was necessary, while some trimming out was necessary. I did not lose a tree—this at a cost of ten cents a tree. I trimmed back the new wood annually, and in three years had a good bearing top, which thereafter bore the largest, finest prunes grown in the vicinity. These I wrapped, packed in twenty-pound boxes and shipped east. They carried well and gave very satisfactory returns. I shipped seven cars one season. They averaged me $1.25 per box in the eastern market, leaving a nice profit. Continuously every year after this gratifying result I thus worked over about

one thousand trees, until forty-four hundred plum trees were all worked over into Italian prunes, with like success and with a loss not exceeding fifty trees. It was said and believed by many that the union would not be good at the graft, and trees thus treated would break down under a heavy load of fruit or from our occasional heavy sleets. This has not proven true—only a suspicious foreboding. Under a heavy weight of fruit and in two heavy sleets the union of the graft, to the contrary, has proven to be as strong as any part of the tree, and it has transpired that this top-grafting is not so difficult and mysterious a handicraft as is generally supposed. Any careful, painstaking man can, in a few hours, learn to set a graft; and so with the waxing, etc. A sharp grafting knife, a trimming saw, a package of cotton batting, a waxing brush, and a heating appliance with kettle of grafting wax, is all the equipment required. For wax, linseed oil and resin, heated and mixed to a right consistence (which is a matter of a little common-sense experience). A man who could not learn to top-graft in a day or two of experience I should not consider an orchardist or fit to work in an orchard.

My grafting has been done in March, April and May, sometimes even after trees were in bloom and leaf. Scions cut in January, or February, tied in bunches and set (cut ends down) in loose earth on the north side of a building, under shed, have always kept well.

Now it transpires that Eastern Oregon, Washington, Idaho, Montana, British Columbia, and other localities, grow successfully the Italian prune, and could probably supply the market of the United States. California set great areas of French prunes, and overdid the business, as Californians are apt to do. Probably California, in the near future, will produce more prunes than the world now consumes, for these and other reasons prunes annually dropped in prices from twelve and one-half to four cents, and five and one-half cents, the present offering. This year the four sizes of French prunes are held at two and one-half cents, and no movement. California is in the hands of a combine, even at these prices, and the eastern market proposes to hold off and break the combine and get prunes yet lower. The few prunes that are sold now are sold outside the combine at lower figures. Canned goods and green fruits are taking the place of the prune. It remains to be seen whether the combine will hold or break. To hold, possibly means that the opportunity to sell will be lost, and stock held over. To say the least the condition is not encouraging. The trade calls for a large black prune. The French prune grown in Oregon is small and light colored and cannot compete with the larger dark French prune grown in the Santa Clara Valley, not to speak of their advantage in sun-drying. I have one thousand five hundred twelve-year-old French prune trees yet to work over; am growing wood of the Burbank sugar prune for scions. California is setting and top-grafting into this prune extensively. Everything is claimed for it. It is three weeks earlier than the French, much larger, sweeter, drying forty-five pounds to the hundred; ever-bearing enormously; tree vigorous, free from blight, or disease of any kind, etc. In 1872 set three hundred Royal Ann cherries, three hundred Black Republican, and later, four hun-

dred Bing, seventy-five Lambert, sixty Governor Wood, fifty May Duke, and one hundred Early Richmond: for some years the Royal Ann and Black Republican brought fifty cents to seventy cents per pound, in ten-pound boxes, for shipment east. This was fairly remunerative, but of late, for some reason, the Royal Ann has not carried well in the long haul; is easily bruised, turns black on the facing, and altogether is an unattractive and unsalable fruit in the eastern markets. We have discontinued shipment. Canneries have come to the rescue and now contract our fruit at three and one-half cents loose, boxes returned. This, also, will be fairly remunerative. Large dark cherries ship well, sell well, and probably will remain profitable. The World's Fair of 1893 revealed the fact that we grow the largest, showiest, and perhaps the finest cherry in the world. Somehow, we ought to do well with our dark cherries. Sixty Governor Wood, and fifty May Dukes, after ten years experience, were worked over into Royal Anns with the same success in the grafting as with the plum. Today only an expert would notice the graft or any change in the growth.

The object of this paper is to say, "Don't dig up old trees because the fruit does not suit you, graft into sorts that will suit you." Spraying, and deep cultivation, will rejuvenate old trees and bring them into vigorous bearing long before you could realize from selling young trees, and at much less expense.

# THE OREGON PRUNE.

By Prof. G. W. Shaw.

In Bulletin No. 45 of this station appeared an article entitled "The Composition of Oregon Prunes." Since the publication of that article numerous analyses of both fresh and cured fruit have been made for various purposes. The present bulletin collects and discusses the results of these analyses. It is a continuation of the work there reported and in some measure the former results are here included in order to bring the comparisons to date. A comprehensive review is here given of the proximate composition of Oregon prunes which is of value both from a scientific and a practical standpoint:

First, in giving the composition of different varieties, thus furnishing a point of departure for development along certain desired lines.

Second, in contributing to our knowledge of the average composition of the fruit, thus giving a basis of comparison in the study of food values: the physical data (proportion of pits to flesh, etc.), showing the relation of waste to actual food material; the chemical data a basis for comparing the nutrients of the prune with those of other fruits.

The work here presented is too meagre for rigid comparison, but it is sufficient to give a close approximation to the character of this fruit. Questions

of the influence of climate, soils, and fertilizers, as well as of those pertaining to fruit curing, will require much more exhaustive work than this station has yet been able to do. These are questions requiring a large amount of time and painstaking labor, and, amid the multitudinous duties pressing in other directions, progress will necessarily be slow.

## COMPOSITION OF THE PRUNE.

The composition of the prune may be expressed as follows:

| | | | |
|---|---|---|---|
| Fruit | (1) Juice. | Water. | |
| | | Soluble Solids. | Sugar. |
| | | | Pectin. |
| | | | Albumenoids. |
| | | | Acids. |
| | (2) Pulp. | Cellulose. | |
| | | Carbohydrates. | |
| | | Pectose. | |

During the process of ripening the first division is increased much at the expense of the second.

*Water*—This constitutes a very large proportion of all fruits in the fresh state, ranging from about sixty-five per cent. to ninety per cent. In the prune it ranges from sixty-five to eighty-five per cent. as will be seen on referring to the tables which appear elsewhere in this bulletin. This water is no different from that occurring elsewhere in nature.

*Sugar*—This exists in fruits mainly as grape or fruit sugar which is widely diffused in nature. It is much less sweet than cane sugar. In fruits this sugar is developed from starch and cellulose during the process of ripening as will be discussed later.

*Pectous bodies* These important bodies are scarcely ever wanting in fruit juices. They are substances, which, on proper boiling of the juice, causes it to form a jelly. The gummy exudation on a baked apple consists of a mixture of these pectous bodies. The pectin of the juice is formed by a chemical change from the pectose of the pulp which is a very characteristic constituent unripe fruit.

*Albumenous substances*—This is a class of bodies which contains about sixteen per cent. of nitrogen and is commonly estimated by a determination of that element. They comprise vegetable albumen, fibrin, and gluten. They constitute a very important class of bodies inasmuch as it is their function, and theirs alone, to form flesh or muscle in the body.

*The acids*—The acids of fruit juices are malic and citric, the former constituting the chief sour principle in the case of prunes. These acids are usually accompanied by a small amount of tartaric acid.

*Cellulose or vegetable fibre*—This occurs in all parts of all plants. It is this which gives strength and toughness to vegetable matter and forms its framework. It is closely related to starch from which it is formed. It is well represented by the fibre of cotton, hemp, and flax.

*Ash*—The ash, or inorganic constituent of fruit, represents the mineral matter which has been removed from the soil. It comprises various salts of potassium, sodium, magnesium, iron, calcium, etc., combined with phosphoric, sulphuric, hydrochloric, and silici acids.

### A DISCUSSION OF THE RESULTS.

The range of all analyses was from fifteen and eight-tenths grams in Italian 955, to sixty-one and five-tenths grams in Silver 974, the average being twenty-nine and three-tenths grams, thus requiring fifteen and eight-tenths prunes to the pound. The average weight of Petites was twenty-two and two-tenths, which is to be placed against twenty-three and six-tenths grams, the average weight of California Petites, so far as published. The average weight of Italian prunes was twenty-nine and eight-tenths grams. The widest range is seen in Petites, fifteen and eight-tenths to thirty and five-tenths grams: the Italian ranged from twenvy-five and three-tenths to thirty-six and six-tenths grams. In Bulletin 45 attention was called to the large size of sample 584, grown in the Umpqua Valley, but this wider range of analyses indicates that there is really little difference in the size of the fruit grown in the Umpqua Valley and the Willamette Valley.

*Proportion of Pits to Flesh* The percentage of pits range from one and eighty-five hundredths in Petite 1044 to eight and seventy hundredths in German 983. The relation of pits to flesh is shown to be as follows in the two leading varieties: Petites, one to sixteen: Italian, one to sixteen and seven-tenths, the latter of which is about the same as the average for all analyses made. The results still show the Oregon prune to carry a little larger pit than the California fruit.

The tentative relation given in a former publication for the proportion of pits to flesh in the Petite (one to fourteen) is shown to have been a little too narrow, and that for the Italian (one to seventeen) a little too wide. In the light of this larger number of analyses, it would appear that Petites carry about sixteen times as much flesh as pits, and Italians about seventeen times as much. Measured by the proportion of flesh, then, the Italian seems to be the more economical of the two varieties, but when the per cent. of water is taken into account, the Petites should be given the preference.

*Juice and Flesh* — As compared with the Italian, the Petite shows the largest proportion of juice to flesh, the average for the latter being seventy-eight and six-tenths per cent., and for the former, seventy-six and four-tenths. If, however, the Silver prune be considered in a sufficient number of analyses, it would probably be found to carry even a higher per cent. of juice than the Petite.

*Sugar and Acid* —It is about the sugar content of the prune that the chief interest centers. Examination of the table shows the average sugar content of all samples examined to be thirteen and twelve hundredths per cent. in the flesh, the soft-fleshed Petite ranging a little above the average, and the Italian somewhat below. The Petite has the advantage of the Italian by two and thirty-three hundredths per cent.— thirteen and eighty-nine hundredths per cent. against eleven and fifty-six hundredths. The California Reports show the French prune to contain on an average (thirteen analyses) twenty-three and ninety-six hundredths per cent. sugar in the juice, which shows a difference, when compared with ours on the same basis, of about four per cent. in favor of the California-grown fruit. The average sugar content is related to that of California prunes as sixteen and six hundredths to twenty

per cent. sugar in the juice. From the difference in climatic and soil conditiions, this is no different than we might expect. Contrasting the Oregon fruit, with sixteen per cent. of sugar in the juice, with that of Germany, carrying six and fifteen hundredths per cent. sugar, we see that the home product is nearly three times as rich in this ingredient.

In their acid content, the prunes examined present a wide variation. The average acidity in terms of sulphuric acid was found to be thirty-five hundredths per cent., which was the same as that found for the Petite prunes. The Italians showed an average acid content of forty-two hundredths per cent; this larger acid content and the smaller sugar content giving this variety of prune its marked characteristic in respect to acidity.

*Albumenoids*—Of this important class of bodies, the maximum one and seventy hundredths per cent., is found in Silver 974, and the minimum, eighty-one hundredths per cent., in Petite 1049. The average for Petites was one and fourteen hundredths per cent. in the flesh, against one and nine hundredths for Italians, still giving the Italians second place, as was indicated in our former publication. In this connection, it is interesting to note that the reports of California analyses (twenty) show as an average eight hundred and thirty-seven thousandths per cent. albumenoids in the flesh, against one and fourteen hundredths per cent. for Oregon fruit. No analyses showing the albumenoids in the edible portion of European prunes are at hand, but in the whole fruit it is reported to be seventy-eight hundredths per cent.

## FOOD VALUE OF FRESH PRUNES.

*Proximate Composition*—A study of the data given in the table under this head shows that fresh prunes cannot be regarded as having a high food value, carrying as they do, an average of seventy-seven and thirty-seven hundreths per cent. of water. Of the two leading varieties grown here the Petites seem to have the largest per cent. of organic matter—twenty-six and ninety-eight hundredths for Petites against twenty-one and ninety-eight hundreths for Italians. Considered from this standpoint fresh prunes would have about the same food value as vegetables, which may be shown by a few analyses as follows:

TABLE V.

| | *Water.* | *Dry Matter.* | *Protein.* | *Nitrogen free extract including fat and fiber* | *Ash* | *Acid.* |
|---|---|---|---|---|---|---|
| Fresh prunes (Oregon; all prunes) | 77.37 | 23.46 | 1.14 | 21.14 | .83 | .35 |
| Fresh prunes (Oregon; Petites) | 72.26 | 27.74 | 1.14 | 25.49 | .76 | .35 |
| Fresh prunes (Oregon; Italians) | 77.07 | 22.93 | 1.09 | 20.56 | .86 | .42 |
| California (all prunes) | 80.20 | 19.80 | .80 | 18.50 | .50 | .40 |
| Plums (California) | 78.40 | 21.60 | 1.00 | 20.10 | .50 | .40 |
| Cherries (Oregon) | 81.30 | 18.70 | .90 | 17.30 | .50 | -------- |
| Cherries (California) | 79.40 | 20.60 | 1.20 | 19.00 | .40 | -------- |
| Potatoes | 78.30 | 21.70 | 2.20 | 17.50 | 1.00 | -------- |
| String beans | 89.20 | 10.80 | 2.30 | 7.70 | .80 | -------- |
| Turnips | 90.46 | 9.54 | 1.14 | 8.63 | .80 | -------- |

A limited number of dietary studies have been made in this country to ascertain the effect of a liberal use of fruits and vegetables on the cost of living, and in this connection the results are interesting. The results of these experiments show the liberal use of either fresh fruits or vegetables increases the cost of living out of proportion to the nutrients furnished.

However, it should be remembered that the value of an article of diet should not be measured entirely by its nutrients, as certain foods unoubtedly have a certain medical and mechanical effect in stimulating the appetite an counteracting any tendency to constipation. Prunes appear to be especially beneficial in this respect. Although containing a relatively small amount of nutrients, they are nevertheless a very valuable article of diet, and should find a wider use in the American household.

### SOIL DRAUGHT OF THE PRUNE.

*The Ash and its Composition* —The ash ingredients are among the more important considerations of any crop, for they represent the materials extracted from the soil. The following, taken from the pen of Prof. W. F. Massey, is so apt that I quote: "There is no doubt that the many failures in fruit productions in the east are due to the exhaustion of the important elements of plant food in the soil. The farmers realize the importance of keeping up the fertility of the soil for the production of their annual crops of grain and vegetables, but somehow the idea has been prevalent that a tree can take care of itself. Men look at the great trees of the forest and see how they grow and that the soil increases in fertility under their influence, and think that the same should be the result in the growing of fruit trees, while they are carrying off continually, not only the fruit that the orchard produces, but in many cases expect the land also to produce food for their stock, and then when the orchard fails to give the expected fruit, and this decrepit condition makes the trees alike prey to insects and fungous diseases, they declare that the climate has changed and they can no longer produce crops for that reason. It has really been because they and their fathers have robbed the soil until the needed food for the production of healthy trees and fruit is no longer available."

There is an old trite saying that "forwarned is forearmed," and it is well worth the while of the horticulturist to heed this warning, for he has no recourse to crop rotation, but makes a constant and one-sided drain upon his soil, which will surely show the effect of such cultivation, either in a lack of proper fruit development or a constitutional disease of the tree.

Work in this direction has progressed sufficiently to give some valuable indications for the future, and when taken into account with the investigations made concerning the soils of the state* the data seems to confirm the results there given, and to indicate the future needs of orchards in Western Oregon.

No complete analysis of the ash of any of the fruits have been made, the work having been limited to the ash and those ingredients important from the standpoint of fertilizing. By referring to the "Statement of Averages,"

*Oregon Bulletin No. 50.

on page nine, it will be noted that the Petite prune draws measurably less on the soil than does the Italian. Considered as a whole, our prunes appear to draw more heavily on the soil than do those of California, and it is also interesting to note that in this respect the latter fall below the draught by European prunes, which stand about midway between those of Oregon and California. The conditions in this respect are set forth in the following table :

TABLE VI.

Showing plant food extracted from the soil by certain fruits.

| Fruits. | Total ash. Per cent. | Per cent. in total ash. | | | | Pounds removed in 1,000 pounds of fruit. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Potash. | Phosphoric acid. | Lime. | Nitrogen per cent. | Total ash. | Potash | Phosphoric acid. | Lime. | Nitrogen. |
| *Prunes:* | | | | | | | | | | |
| Oregon | .83 | 53.61 | 15.60 | ------ | .220 | 8.3 | 4.45 | 1.30 | ------ | 2.20 |
| California | .49 | 63.83 | 14.08 | 4.66 | .162 | 4.9 | 3.10 | .68 | ------ | 1.62 |
| European | .63 | 59.19 | 10.79 | ------ | .122 | 6.3 | 3.73 | .95 | ------ | 1.22 |
| *Cherries:* | | | | | | | | | | |
| Oregon | .50 | 40.37 | 11.06 | 1.08 | .169 | 5.0 | 2.01 | .55 | .05 | 1.69 |
| European | .58 | 34.83 | 10.34 | ------ | .180 | 5.8 | 2.00 | .60 | ------ | 1.80 |
| *Strawberries:* | | | | | | | | | | |
| Oregon | .42 | 39.86 | 13.99 | 4.20 | .190 | 4.2 | 1.67 | .59 | .18 | 1.90 |
| Other localities | .60 | 50.00 | 23.31 | ------ | .150 | 6.0 | 3.00 | 1.10 | ------ | 1.50 |
| Apples (average) | .39 | 48.72 | 2.56 | ------ | .130 | 3.9 | 1.90 | .10 | ------ | 1.30 |
| Wheat (grain) | 1.57 | 24.84 | 44.58 | ------ | 2.36 | 15.7 | 3.90 | 7.00 | ------ | 23.60 |
| Oats (grain) | 2.98 | 20.80 | 24.16 | ------ | 2.06 | 29.8 | 6.20 | 8.20 | ------ | 20.60 |
| Sugar beets | 1.04 | 46.17 | 9.61 | ------ | 2.20 | 10.4 | 4.80 | 1.00 | ------ | 2.20 |

*Potash*—In the ash of prunes, cherries, strawberries, and apples, potash is the leading ingredient. In prunes and apples it constitutes about one-half of the total ash; in cherries it constitutes about two-fifths. Attention is called to the difference between the proportion of potash in the ash of the fruits and that of the grains, in the latter constituting only about one-sixth to one-fourth. Attention of horticulturists is especially called to this fact, and still further to the fact that the soil conditions as set forth in Bulletin 50* are such as to demand close attention to this element. The soils of the Willamette Valley are inclined to be weak in this ingredient, due partly to a limited amount in the parent rock and partly to the heavy leaching to which the soils have been subjected. When fertilizers are used on the fruit orchards west of the Cascades, they should invariably be rich in potash. It is quite likely that the low supply of potash of these soils has more or less to do with the smaller sugar content of the Oregon-grown prune, and the tendency to the trees themselves to succumb to fungus attacks. To gain some knowledge of the effect of potash salts applied to prunes, some experiments were inaugurated a few years since, but on account of untoward circumstances, the data so far obtainable has not been as definite as is desirable, although the limited results pointed toward an increase in the sugar content of prunes.

This is in accord with the results obtained at the California station, which indicated a slight increase in the sugar contents of the orange, and also ac-

*This bulletin can be had free on application to the station.

cords with the statement of Mr. Dosch, an observant horticulturist, as to a noticeable effect on his trees after a treatment with muriate of potash.

*Phosphoric acid* It will be noted that the fruits mentioned above draw more lightly on this ingredient than do the cereals. On account of the abundant supply it is not at all likely that phosphate fertilizers will be needed to any great extent on prune soils of the northwest.

*Nitrogen* - This element is not an ingredient of the ash, but inasmuch as it is one of the most important from the standpoint of fertility it demands some mention. Of the fruits considered, the prune draws most heavily on this element, but much less so than the cereals. On the bottom lands of the Willamette Valley, where the drainage conditions are very poor, and the available lime supply quite limited, there will early be a call to replace this element by the use of leguminous crops. Such crops should be grown in winter to good advantage and turned under in the spring, thus saving much plant food that would otherwise be lost through leaching. It is recommended also to make a liberal use of lime, which will tend to improve the condition for humifcation by neutralizing the natural acidity of these soils. This also applies to the bench lands, as they are, as a rule, more limited in their lime content than the bottom lands.

## FERTILIZER FOR PRUNES.

In view of what is known relative to the soil conditions of Western Oregon, I beg to suggest the following formula as probably being well adapted to the needs of fruits in general, and prunes in particular:

| | Per acre. |
|---|---|
| Air-slacked lime | 2,000 pounds |
| Muriate of potash | 400 pounds |

This mixture may be well applied to some leguminous crop which is to be turned under as a green manure to furnish the nitrogen supply. Wood ashes may be substitued for the muriate if they can be obtained in considerable quantities at a reasonable price. It would take about one hundred bushels of ashes weighing four thousand five hundred pounds to be equivalent to the four hundred pounds of muriate of potash. This application should be sufficient for several years. Fruit trees, being slow growing, appropriate plant food slowly, and if it is thought best to use any phosphate probably nothing would be better than finely ground bone. No mention is made of this material as it is not likely to be needed, except in special cases. It should be borne in mind that no specific rule can be laid down in this matter of fertilzers, as conditions are so variable, but the farmer must keep in mind general principles and use his intelligence in applying them to his conditions.

## THE COMPOSITION OF THE CURED PRUNE.

Of all the methods for preserving fruit none is of so great importance to the American people as that of fruit evaporation. Of all fruits so preserved the prune certainly takes first rank. The reader must not confound the

term evaporated fruit with that of dried fruit of years agone, for the newer process gives a cured product much superior to the sun or oven dried article, retaining as it does much of the original color and flavor, being soft, pliable and palatable to eat out of hand. The process of evaporation has for its object, primarily, to drive off a sufficient amount of moisture to make the fruit keep, and to do this in such a manner as to leave the fruit in the condition above described, and leave the flesh of a transparent appearance; a clear yellow in the case of the French prune, and an amber in the case of the Italian. No prune which has not these characteristics has been properly cured.

AVERAGE COMPOSITION OF CURED PRUNES.

| | *All prunes.* |
|---|---|
| Waste (pits) | 12.95 |
| Edible matter | 87.04 |
| Water | 19.27 |
| Dry matter | 80.73 |
| Albumenoids | 2.03 |
| Sugar | 30.97 |
| Carbohydrates (including fibre and fat) | 45.51 |
| Ash | 2.22 |
| Total | 80.73 |

There are two or three samples in the table which are worthy of special attention. The first is 1284, called by the grower, Mr. Skidmore, of Wilbur, Oregon, "The American Seedling." These, I think, were the finest prunes I had ever seen. Mr. Skidmore informed me that the fruit sent was not exceptionally large. It will be noted that the fruit carries over ninety per cent. of edible matter, and is not approached in this respect by any except "The Dosch," and the Willamette. Another point worthy of note is the exceptionally high content of albumenoids, over one per cent. higher than the average. If the tree is horticulturally suited to the Oregon condition it is certainly worthy of close attention. Other varieties promising distinct advantages over either the Petite or the Italian, from the food standpoint, would seem to be the Willamette and The Dosch. It is impossible to judge of the sugar value of any of these varieties until samples of the fresh fruit have been examined.

The average of all analyses shows prunes to contain about seven times as much edible matter as waste (pits). The fruit which had satisfactory keeping qualities carried about twenty per cent. of water, From the observations made I do not regard it as safe to leave a greater quantity of water than this in the fruit. In most cases where the fruit carried over this there was a tendency toward mould. Much of the fruit, it will be noted, carried considerable less than this, which accords with the idea of the better horticulturists that much of the product is overdried. The fact that this product carries about eighty per cent. of dry matter shows that it is of high food value. About three-eighths of this is composed of the carbohydrates which serve to develop energy and fat, hence prunes must be considered as essentially a fattening food, and should be used with other foods rich in nitrogen.

# OREGON PRUNE INDUSTRY.

By H. B. Miller, Eugene.

The shipment of five hundred cars of dried prunes from Western Oregon during the season of 1898 settled the question as to Oregon's future in the production of prunes. Western Oregon is, beyond all doubt, an excellent prune-growing section, and the industry is sure to increase for many years to come.

The various productions of the world are rapidly concentrating into localities where the soil and climatic conditions are especially favorable for their most economic production; in fact, the most important problem of horticulture is the selection of soil and climate particularly adapted to the fruit in hand. This fact is becoming so apparent that soil physics and chemistry are necessary sciences in all departments of agriculture, and much better opportunities are open for young men in these lines than in law or medicine.

There is, perhaps, no greater waste of effort in all the industries of Oregon than in horticulture. The state is covered from one end to the other with fruit trees of many kinds that will never produce fruit at a profit. I feel perfectly safe in saying that not one tree in ten that has been planted in Oregon during the last twelve years will ever produce fruit at a profit, and am convinced that no other line of production will show nine-tenths of waste. Small and large monuments of ignorance and folly can be found in the scrawny, scabby, scrubby trees in evidence all over the state; and this same wastefullness still goes on. A good year, with good prices for apples, starts apple-tree planting on all classes and conditions of soil, and powder and dynamite are used to blow holes in uncongenial soils, where the tree is planted to become a source of disease, and finally wind up a failure. Prune trees by the thousand have been planted where their roots were covered with water for several months in the year, and as they grew sickly the owner would begin a scientific hunt for the difficulty in some insect or fungus that would appear active on the tree because the tree was weak on account of improper soil conditions. Again, thousands of trees are found planted upon soil too shallow to maintain a tree ten years old and mature a crop of fruit. In other places trees are planted on soil so deficient in lime and potash as to preclude the possiblity of growing a successful orchard.

## DO NOT PLANT IN SHALLOW SOILS.

The one great mistake made in the planting of orchards lies in planting on shallow soils. An equally great failure is made by planting on soils where the physical conditions prevent the roots from penetrating to any great depths. A chemical analysis may show an abundance of potash, nitrogen and phosphoric acid in the soil even to a great depth, but some clay strata, water-level, or impervious condition may prevent the roots of the trees from securing the necessary food elements.

It usually requires from six to eight years to bring a good prune tree into good bearing, and in many cases, where the roots have only shallow soils from which to gather food, they will have the available food consumed shortly after coming into bearing, and the fruit production begins to fail. The orchardist, after spending years of care, toil, and expense, struggles then to overcome inevetable results, and finally gives up the task and pronounces prune growing a failure, while the true cause of his failure was his primary mistake of selecting improper soil or bad physical soil conditions.

The greatest prune-growing section in the world, the Santa Clara district in California, where trees grow to great size and at thirty years of age continue to produce excellent fruit at a fair profit, has such depth of soil that the roots of the trees continue to increase in depth and find available elements for tree and fruit many feet below the surface. It is this great depth of soil and available elements of food that gives the value of $700 and more per acre to the best prune orchards of Santa Clara Valley. A ten-foot augur should be used in boring the soil to determine the conditions before planting an orchard.

Many of our inferior orchards were planted in Oregon at a time when prunes were bringing ten and twelve cents per pound, and men were led to believe that the world would take all the prunes that Oregon could ever produce at these prices. Hundreds of these orchards that have been profitable at high prices, are failing because the available soil has been exhausted and the fruit has become inferior, the price has been coming down, and we are having the cry of overproduction and that prune growing is a falure in Oregon. Prune growing is not a failure in Oregon, and, in my opinion. never will be, although prune growers are failing, and will coutinue to fail by the hundreds for years to come. Hundreds of men have failed in the sawmill business in Oregon, and hundreds more will fail in the future, but lumbering in Oregon is not a failure.

Why will prune growing continue to be a success in Oregon? First, the consumption of Oregon prunes is increasing at a rapid rate. Its food value, at the cost it can be given to the consumer, is such as to fix it permanently in the diet of the great mass of American people. I do not hesitate to make the statement that there is no fruit of equal food value with the Oregon prune that can be produced at as low a cost. If this proposition is true, its future is assured.

## COST OF PRODUCTION.

Many orchardists are finding it unprofitable to produce prunes at five cents per pound, and are failures on that account. The Italian prune, the principal prune in Oregon, is grown in large quantities throughout the Willamette and Umpqua valleys, and to a limited extent in Rogue River Valley. Marion County produced more than any other county in 1898. This prune can be grown successfully in almost every section of Western Oregon. In the Willamette Valley the cold, wet springs sometimes interfere with the forming of the fruit, and sometimes causes a failure of the crop. The Umpqua Valley so far has proved to be the section where the crop is the most regular, although many of the orchards in that valley failed in 1899. The

warmer climate of Rogue River makes it a less desirable climate for the production of the Italian prune than the Umpqua or Willamette valleys. The Italian prune seems to require the cool and moist climate, such as prevails in the valleys of Western Oregon during the summer, in order to reach perfection. In these localities, where planted on deep, well-drained soil, the trees thrive well and the production of fruit is enormous. The prune best adapted to the Rogue River Valley is the French prune. The warmer climate of this valley brings this fruit to a higher state of perfection than the cooler and more moist conditions existing further north.

## BASIS OF SUCCESSFUL PRUNE CULTURE.

The permanent cost of production of first-class fruit is the economic basis of successful prune growing. If the Italian prune is required in large quantities to meet the food demand of the people of the United States, and can be produced, the industry will thrive under skillful direction. The present value of the choice prune land in Oregon ready for planting is about $50 per acre, the cost of trees and caring for orchard for seven years will add $75 per acre, so that a choice prune orchard at eight years, the beginning of good bearing, will be about $125 per acre.

An eight-year-old tree should produce at least thirty pounds of dried product that should bring three cents per pound. The cost of gathering and drying prunes in Tulare County, California, where the total product brings the growers nearly $500,000 per year, averages between $15 and $17 per ton. The cost in the Santa Clara Valley is given at $12 to $15 per ton. It has generally been conceded that the cost of evaporating in Oregon was much in excess of this; but careful accounts, by competent men, show that the cost will vary from one-half to three-quarters of a cent per pound. This makes the expense no greater than in California.

The cost of production, then, and preparing for market will range from one cent to one and one-half cents per pound. Thirty pounds of dried prunes, at a profit of one and one-half cents per pound, would give forty-five cents per tree profit, and, with ninety trees to the acre, this would give an average profit of $40 per acre. A prune orchard that will not, on an average, bring these results, has either in its inception or management improper conditions.

In order to maintain a successful and substantial condition of the industry, the grower must, through organizations for marketing, seek to give his product to the consumer at the lowest cost of marketing. It must become his duty now to find the cheapest and best method of marketing his fruit. The present method of marketing is awkward and expensive, and the great task now for the fruit men of Oregon is to develop associations for marketing their fruit.

# POLLINATION IN ORCHARDS.

By Prof. G. W. Fletcher.

## 1. VARIOUS REASONS WHY FLOWERS DO NOT SET.

All observing fruitgrowers have seen trees which blossom full but do not set a fair amount of fruit: many have found their orchards unprofitable for this reason. It is a practical point to know the causes of this loss and the best way to prevent it.

### NOT ALL THE FLOWERS CAN SET FRUIT.

In the first place, but a small percentage of the blossoms set fruit anyway, even in the most favorable seasons and with the most productive varieties. In blossoming time a Japanese plum tree is a mass of white, carrying scores of flowers on a single branch: yet scarcely a dozen fruits may set on that twig, and some of those must be removed or the tree will overbear. In the pollination work at Ithica in 1899, forty-seven hundred and twenty-five untouched blossoms, including apples, pears, plums, and apricots, set but six hundred and seventeen fruits. The blossoms counted were those on the tree at large, and were used for comparison with the hand crosses. This is about one fruit for every eight blossoms: yet most of the trees set what would be called a good crop. All of these blossoms were apparently uninjured by the winter, and the weather during the blossoming season was very favorable for the setting of fruit.

This normal failure in the setting of fruit blossoms may be due to a number of causes: as poorly nourished fruit buds, lack of pollination, or winter injury to the pistils which cannot be seen with the eye alone. It is usually a distinct advantage to the fruitgrower, as it saves thinning. If all plum blossoms set fruit, the expense of thinning would be multiplied many times. Only when the failure of fruit blossoms to set becomes general does the fruitgrower feel the loss and call for an explanation.

This wholesale failure in the setting of fruit is often called self-sterility. Properly speaking, a self-sterile tree is one which is self-unfruitful: it must have other varieties near it in order to bear well. But it appears that self-sterility in orchard fruits is often confused with the unfruitfulness resulting from other causes. It would, therefore, be well to clear away this confusion at the outset, in order that the discussion of self-sterility may be better understood. The influences which sometimes make trees unfruitful, which are

often confused with the unfruitfulness resulting from self-sterility, are (1) heavy wood-growth, (2) the attack of fungi on the blossoms, (3) frosts, (4) unfavorable weather during the blooming season. It should also be said that a tree is not self-sterile when it does not blossom. This bulletin does not attempt to tell why trees do not bloom, except that it is generally due to poor management. The only thing which concerns us now is why trees which blossom full do not set a reasonable amount of fruit.

BLOSSOMS MAY DROP BECAUSE OF HEAVY WOOD-GROWTH.

Young trees generally set little or no fruit the first few years, when they are growing fast, although they may blossom full. With most varieties this early dropping of the blossoms occurs only two or three seasons, but Northern Spy and a few other varieties of apples are often unfruitful ten to thirteen years from this cause. Older trees may show the same results if stimulated too highly with nitrogenous fertilizers. The logical remedy is to check this excessive growth of wood by withholding nitrogen or by putting the orchard into sod for a few years.

72—Winter injured fruit buds of Royal apricot.

The direct cause of this unfruitfulness is not known. The stamens and pistils are usually well developed and pollen may be produced in abundance. Since young trees drop their blossoms as badly in a mixed orchard, where other pollen is available, as when alone, the trouble probably lies more with the pistils than with the pollen.

Up to this limit of excessive growth there is a fairly constant relation between the vigor of a tree and its productiveness. Lack of vigor causes much more unfruitfulness than excessive vigor. If a tree is unhealthy or dying because of poor nourishment, few of its blossoms are strong enough to set fruit. The same results may follow if the tree is exhausted by overbearing.

BLOSSOMS MAY BE KILLED BY FUNGI.

If the weather is warm and wet in early spring, conditions are favorable for the growth of fungi, and it sometimes happens that fruit blossoms are "blasted" by the early growth of these parasites. The common brown-rot fungus often kills peach blossoms and may seriously decrease the setting of fruit. It is probable that this fungus sometimes attacks plum and cherry blossoms also. Apple and pear scab may kill the blossoms, but often it kills the young fruits soon after they are set. Wherever spraying is practiced faithfully, the killing of fruit blossoms by fungi need not occur, especially if one thorough application is made to the trees before the buds open. The killing of pear blossoms by blight, however, cannot be prevented by spraying. The blossoms on Kiefer and LeConte trees are especially liable to be destroyed by the growth of blight microbes, which are carried from flower to flower. The only way to prevent this loss is to have no blighted trees in or near the orchard.

### WINTER AND SPRING FROST MAY INJURE THE BLOSSOMS.

The unfruitfulness arising from winter or spring frost injury is sometimes confused with self-sterility. Various forms of winter injury to fruit buds are shown in Figs. 72–77. At A in Fig. 72 is a fruit bud which has been completely winter-killed and has no growth whatever. B and C are buds which will never be able to open: while D is a very weak blossom which cannot set fruit. The single open flower on this branch is the only one which can possibly set fruit. A winter-injured cluster of Bietigheimer blossoms is seen in Fig. 73, with a section of one bud in Fig. 74 to show the shriveled stamens and pistils. The leaves in this cluster came through all right, but the flowers were injured. The single flower which has expanded is too small and weak to develop into fruit. These winter-injured clusters were common on all varieties of pears, particularly Angouleme and Manning Elizabeth, and on some varieties of apples, in the spring of 1899.

73—Winter-injured fruit buds of Bietigheimer apple.

Two forms of winter or spring frost injury to the pistils are seen in Figs. 75 and 76, with a normal blossom for comparison in Fig. 77. A common form of injury is that in Fig. 75, in which the pistil is blackened and stunted, having made no perceptible growth during the opening of the flower. These pistils always drop from the tree soon after the petals have fallen. Another and not less common form of injury is that in Fig. 76, in which the pistil has made a partial growth but has no well-developed ovary. Unless a careful examination is made, blossoms like this would not be considered as winter-injured. Of fifty which were tagged, none gave fruit, although several fruits grew to the size of peas. The killing of the pistils is the most common form of winter-injury to fruit buds. Some of the native and Japanese plums had as high as eighty per cent. of defective pistils last spring, but with their enormous amount of bloom this did not materially decrease the crop of fruit which the trees were able to carry. The Japanese plums bloom so early that their blossoms are liable to be injured by frost in the middle states and south.

74—Section of one bud in Fig. 73.

It is thus seen that the injury to fruit blossoms from cold is of all degrees. During the opening of a normal flower, the pistil grows. It is often taken for granted that if this growth occurs the pistil is uninjured; but it may be that even though a pistil reaches its full size, it may yet be so injured that it cannot develop into fruit. In 1899 about ten per cent. of the blossom buds of a Royal apricot opened fully, like the one in Fig. 72. All of these blossoms appeared to be perfect, with long pistils, plump ovaries and well-developed stamens. Yet hardly a dozen fruits set on the whole tree, although the weather during the blooming season was ideal, bees

75—Catherine apricot: injured pistil.

were numerous, and some of the flowers were even crossed by hand with the pollen of other varieties. Since the variety had already shown itself so susceptible to winter-injury, it is probable that this wholesale failure was due to the weakened vitality of the pistils, which could not be seen with the eye alone.


76—Catherine; injured pistil.

Some of the imperfect development of flowers which we attribute to winter-injury may be caused by unfavorable conditions during the previous season, when the buds were being formed; yet it seems likely that winter-injury to pistils is more common and more serious than appears at first sight. These remarks on winter-injury are introduced simply to emphasize the fact that all blossoms which do not set fruit are not self-sterile: and also to promote a more careful discrimination between the various causes which decrease the setting of fruit.

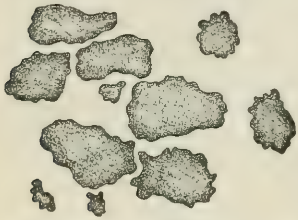
## RAIN MAY INJURE FRUIT BLOSSOMS.

The unfruitfulness which often follows a rain during the blooming season is sometimes confused with self-sterility. A careful fruitgrower watches the weather anxiously when his trees are in blossom, for he knows this is the most critical period in the growth of the crop. Injury to fruit blossoms from rain is common wherever fruit is grown, but is particularly serious along the Pacific Coast and near the shores of the Great Lakes. It has been estimated that more fruit is lost in California from cold rains during blooming time than from all other causes combined. Like winter-injury to fruit buds, there is no way of preventing this loss except to secure a more favorable location, since it is not in man's power to prevent rain, however much he may be able to induce it by bombarding the sky. Nevertheless, it is interesting to know in what way rain decreases the setting of fruit.


77.—Catherine; normal flower.

If a rain comes while the trees are in full bloom the pollen is washed from those anthers which have already opened, and is thus prevented from reaching the stigma. Should the rain be a short one, no serious harm need result from this loss of pollen, for the unopened anthers will burst and pollination will begin again soon after the sun comes out. The washing away of pollen has very little influence in decreasing the setting of fruit, particularly when the rain is short. There will generally be enough pollen to supply the pistils before or after the rain.

The poor setting of fruit, which often follows a long rain and sometimes a shower, is due more to a loss of vitality in the pollen or to some mechanical injury to the pistils; also, in large measure, to the fact that bees and other insects which promote the beneficial cross-pollination between varieties are absent. If the rain lasts for several days, the pollen may lose its vitality. After a week of rainy weather at Ithaca, in the spring of 1898, nearly all the pollen of the apricots then in bloom was disorganized and stuck together, so that it could not possibly grow and fertilize the pistils. Some of this pollen is shown in Fig. 78. It is also natural to suppose that a hard rain may wash off, dilute, or otherwise injure the juices of the stigma so that the pollen cannot germinate after it falls upon the stigma. Perhaps a long "spell" of wet weather may even kill the pistils after they have been fertilized.



78.—Pollen injured by rain. Much magnified. Compare Fig. 80.

Thus a rain during the blooming season may decrease the setting of fruit in four ways: (1) By preventing the pollen from reaching the stigma, both because it is too wet to fly and because pollen-carrying insects are absent. This is important only when the rain lasts several days and most of the pistils pass their receptive state before the rain ceases. (2) By destroying the vitality of the pollen. (3) By injuring the stigma. (4) By preventing fertilization or the germination of the pollen because of low temperature.

### THE BLOSSOMS MAY BE INJURED BY STRONG OR DRYING WINDS.

Near the sea and large lakes, fruit blossoms may be whipped off by very severe winds. In such cases a mixed windbreak of deciduous and evergreen trees may be used to advantage. Drying winds during the blossoming season are not common in the east, but are often serious in some parts of the west. Luther Burbank, one of our best observers and experimenters in orchard pollination, says a dry wind sometimes causes a short fruit crop in some parts of California by drying up the juices of the stigma so that the pollen cannot germinate.

## II. SELF-STERILITY.

There have been described in the preceding pages some of the influences which decrease the setting of fruit. These were mentioned only to make more clear a talk about self-sterility, an influence which is second only to the winter injury of fruit buds in the loss caused to the commercial fruit-grower. Since the loss from unfavorable weather usually cannot be prevented, while the loss from self-sterility can, in a large measure, the latter subject deserves more than the brief notice which has been given to the former at this time.

There are some trees which blossom full year after year, but set little fruit, even in the most favorable seasons. These trees are usually in solid blocks, or at a distance from any other variety. Planting near them other trees of the same variety does not make them fruitful; but if trees of other

79.—Coe Golden Drop. But one fruit has set; the other will soon drop.

varieties are planted near, they are often made fruitful. A self-sterile variety is one which is unable to set fruit when alone: in order to be productive, it must be planted near some other variety. Two varieties very commonly self-sterile are Miner and Wild Goose plums. Large blocks of the Kieffer pear and some of the great prune orchards on our Pacific Coast have been unprofitable from this cause. Besides these striking examples, there is reason for believing that much of the unsatisfactory fruiting of orchards all over the country is due to the isolation or indiscriminate mixing of varieties.

### THE MAIN CAUSE OF SELF STERILITY.

In general, the cause of self-sterility is that the pollen of a variety is unable to fertilize the pistils of that same variety. That is, if pollen from a Wild Goose blossom falls on a Wild Goose pistil, whether on the same tree or any other Wild Goose tree, no fruit will result, as a rule. The pollen of a self-sterile variety may be, and generally is, produced in abundance, and is well formed. Wild Goose generally bears pollen freely, although it is one of the most self-sterile varieties in cultivation. The Bartlett pear is often self-sterile, yet its pollen is perfect. Fig. 80. The pollen of a self-sterile variety also has vitality, for it will fertilize the pistils of other varieties. For example, plant together trees of the two self-sterile varieties, Miner and Wild Goose, and both will often be made fruitful, because the pollen of each, though infertile on itself, is fertile on the other. It is not known in what way this infertility is usually shown, but with Wild Goose, at least, the pollen grain actually germinates and the pollen tube passes down to the ovule. Why the two sexes are unable to unite after having got thus far, the embryologist has not yet told us.

80.—Pollen of Bartlett. Much magnified.

### MINOR CAUSES OF SELF-STERILITY.

Aside from the impotency of pollen, the main cause of self-sterility, there may be several other incidental causes. Goff and Waugh have shown that self-sterile varieties of native plums often have a large per cent. of pistils which are too weak to develop into fruit. This could not be a general cause of self-sterility, however, for self-sterile varieties can usually be made fruitful by planting other varieties near them. This shows that there are enough sound pistils on the tree for a good crop of fruit, provided they receive the right kind of pollen.

Again, the blossoms of some varieties may produce but a small amount of pollen. When these varieties are planted alone they may not have enough pollen to set a good crop, even though the pollen is fertile on its associated pistils. The amount of pollen which flowers produce is greatly modified by weather conditions and the vigor of the tree.

Many plums are worked on Marianna and Miner stocks, two of the most self-sterile varieties in common cultivation. It has been thought that possibly there might be an influence of the stock on the scion in the direction of self-sterility, but this assumption seems to be without foundation.

Finally, the stamens and pistils of a tree may not mature simultaneously, which would make a tree unfruitful, unless pollen is supplied from other sources. With many varieties of orchard fruits the pistil of each flower matures a little before the stamens: and not infrequently the stamens mature before the pistil is ready to receive the pollen. But there is usually enough variation in the opening of flowers on the same tree to promote pollination with each other, and so prevent serious loss from this alternate ripening of the sexes. Defective pistils, scanty pollen supply, and the premature ripening of either pistils or stamens may often be important in determining the fruitfulness of a tree; but the main cause of unfruitfulness in most self-sterile varieties is the failure of the pollen to fertilize its associated pistils. This cause cannot be removed, but its injurious results may often be prevented by a judicious selection of varieties.

### A PRACTICAL APPLICATION.

The practical bearing of the self-sterility problem is this: There are certain varieties of fruit which we wish to grow largely for the general market, but we find that they are not productive when planted alone. They need the pollen of other varieties to make them fruitful. Then we must do what some of our most intelligent fruitgrowers have been doing for years -- plant other varieties near them as pollenizers. Orchardists along the Atlantic Coast have been obliged to do this with Kieffer. The Californians often find it necessary with their prunes; and many an unproductive orchard of Wild Goose has been made fruitful by being partially top-worked with another variety. Cross-pollination of varieties is no longer a theory; it is an established orchard practice.

### THE HISTORY OF THE SELF-STERILITY DISCUSSION.

There are at least sixty species of plants which are known to be often sterile with their own pollen. The study of this problem had its origin mainly in the investigations of Darwin. While Darwin was not the first to observe the value of cross-pollination, he so far exceeded his predecessors in this, as in most other work, that the beginning of a systematic study of self-sterility is usually dated from the publication of his "Origin of Species" in 1859. Self-sterility in orchard fruits was first studied by Waite, under the direction of the United States Department of Agriculture. Since the publication of his work, in 1894, (Bul. 5, Div. Veg. Pathology) many experimenters have continued the lines of study indicated by him.

The unfruitfulness arising from self-sterility had been noticed many years before by fruitgrowers. The benefit which some varieties gained by being planted near other varieties also had been noticed, and mixed planting was often practiced with success, particularly with Wild Goose and Miner. There are now one hundred and twenty-six entries in my bibliography of references to "barren" trees in American literature before the appearance of Waite's bulletin in 1894. The real cause of this barrenness, however, was not known definitely before the experiments of Waite: although it had long been supposed by many to be the pollen. Of late years, many experimenters

have done careful work along this line. Among these are Goff, Waugh, Craig, Kerr, Crandall, and Heideman, on orchard fruits: Beach, Earle, T. V. Munson, Whitten, and Green on grapes. The California and Oregon state boards of horticulture are also making a special inquiry on the self-sterility of prunes.

### VARIETIES WHICH ARE OFTEN SELF-STERILE.

Self-sterility is not a constant character with any variety. It is influenced by the conditions under which the tree is grown, as are the size, shape, and color of the fruit. The adaption of a variety to soil and climate has much to do with its self-fertility, and if a tree is poorly nourished it is more likely to be infertile with its own pollen. No one can separate varieties of fruit into two definite classes, the self-sterile and the self-fertile. Thus, Bartlett and Kieffer are often self-sterile, but there are orchards of both which are self-fertile. The same may be said of many other varieties. The best that can be done, therefore, is to give a list of those varieties which tend to be more or less self-sterile and which it would be unsafe to plant alone.

Following is a conservative list of these risky varieties, drawn both from experimental work and from the reports of over five hundred fruitgrowers who have favored me with their experience. Pears: Angouleme (Duchess), Bartlett, Clapp, Idaho, Kieffer, Nelis. Apples: Belleflеur, Primate, Spitzenberg, Willow Twig, Winesap. Plums: Coe Golden Drop, French prune, Italian prune, Kelsey, Marianna, Miner, Ogon, Peach, Satsuma, Wild Goose, and according to Waugh and Kerr, all other varieties of native plums except Robinson. Peach: Susquehanna. Apricot: White Nicholas. Cherries: Napoleon, Belle de Choisy, Reine Hortense. Most of these varieties are self-fertile in some places, but the weight of evidence shows them to be uncertain.

It must not be inferred that all other varieties are always able to set fruit when planted alone. There are some, however, which have exceptionally good records for fruitfulness when planted in solid blocks, other conditions being favorable. Among these are, Apples: Baldwin, Ben Davis, Fallawater, Janet, Oldenburg, Rhode Island Greening, Red Astrachan, Smith Cider. Plums: Burbank, Bradshaw, De Soto, Green Gage, Lombard, Robinson, and some of the common blue Damsons.

All this goes to show that the problem of self-sterility is as much a study of conditions as of varieties. We can set no limits: we can only indicate tendencies.

The great and growing Kieffer pear industry in the Eastern United States warrants a fuller discusion of this variety. Many large blocks of Kieffer are being planted with no other varieties intermingled, and it is an important point to know whether this practice will give the best results. Eight blocks of Kieffer in New Jersey and Deleware have been reported as completely or partially unfruitful because of self-sterility, and there are also many solid blocks of Kieffer in the same states which bear well. Kieffer is unreliable, especially on the Delaware peninsula. A large block of Kieffer may be productive, but it does not pay to take the risk, particularly since

the pollen of other varieties is likely to give better fruit, as will be seen later on.

### SELECTING THE POLLENIZER.

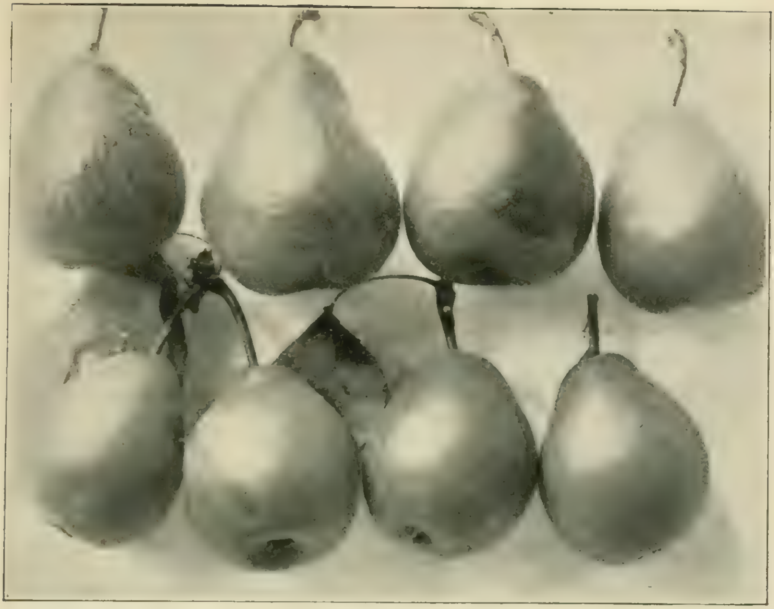
Let us suppose that we intend to plant a large block of an uncertain variety, as Kieffer, because it has distinct merit as a market sort. We wish to plant with it some other variety to make it fruitful. There are two points to be considered when selecting a pollenizer for Kieffer or for any other self-sterile variety: the choice should not be indiscriminate. These are simultaneous blooming, and mutual affinity.

The first and most important point is that the two shall blossom together, since the only way in which a pollenizer can make a self-sterile variety fruitful is by supplying it with pollen. This means that the pistils of the self-sterile variety must be receptive when the stamens of the pollenizer are ripe, which is possible only with simultaneous blooming.

The comparative blooming of varieties is more or less a local problem. Differences of latitude, altitude, soil, nearness to large bodies of water, and weather conditions during the blooming season not only hasten or retard the time of blooming, but also disturb the order in which the different varieties open. Varieties blossoming together at one place may not at another. The best that can be done in the way of generalizing on the question of simultaneous blooming for cross-pollination is to make a chart for each well-marked geographical district. To this end several hundred fruitgrowers have kindly taken notes the past two seasons, and when sufficient data is collected these charts may be published. This will indicate in a general way which of our standard commercial varieties may be expected to bloom together: yet each fruitgrower should be prepared to make minor corrections for his own farm. Until more definite knowledge is available, each orchardist should learn how varieties bloom in his own neighborhood before planting them for cross-pollination. It is better, but not always necessary, that the two should bloom exactly together; if they overlap two or three days that is long enough.

It is sometimes desirable to plant varieties of different botanical species together for cross-pollination, but this will often be impracticable because of the difference in their blooming seasons. Thus the oriental pears, as Kieffer, and the European pears, as Bartlett, usually do not blossom together. Kieffer generally blooms several days before Bartlett, hence it is necessary to pollinate it with a variety of its own class, as Le Conte or Garber. In some places, however, the two groups blossom approximately together, and then varieties like Bartlett and Seckel should be used in preference to Le Conte or Garber, since their fruit has a greater market value and the trees are less likely to blight. Whenever the European pears are used as pollinizers for Kieffer it would be well, if otherwise practicable, to work them on quince roots. Standard Kieffers will often bloom two or three years before standard Bartletts planted at the same time, and unless early blooming dwarfs are intermingled they may be unproductive these first few years.

The three classes of commercial plums,—Japanese, domestic, and native,—will usually bloom at different periods in the order named; but when a



81.—Seckel. From Kieffer pollen above, from Lawrence pollen below.

82.—Stark. From Wagner pollen above, from Stark pollen below. Marked benefit cross-pollination.

"spell" of warm weather succeeds a cold and backward spring, varieties of all these groups will come on nearly together and cross-pollination will result. In some places the blooming seasons of these groups overlap so that some varieties of each might be used regularly for cross-pollination.

## THE MUTUAL AFFINITY OF VARIETIES.

Another point to be looked after when selecting a pollenizer for Kieffer, or for any other self-sterile variety, is the mutual affinity of the two. That is, will the pollen of the pollenizer fertilize the pistils of the self-sterile variety readily and also develop them into high-grade fruit? At present but little is known about this matter. Taking first the possibility of cross-pollination between varieties of different species, there seems to be no doubt but that many varieties of native, Japanese, and domestic plums will fertilize each other. Orchard experience in many places indicates this: as when Satsuma is used to pollinate Coe Golden Drop in California prune orchards. Several successful crosses between the three were also made at Ithaca the past season. Among these are Abundance × Grand Duke (Fig. 84), Georgeson × Wayland, Berckmans × Coe Golden Drop, Coe Golden Drop × Satsuma. That is, if we wish to use Satsuma as a pollenizer for Coe Golden Drop, or Lombard for Wild Goose, the probability is that the combination would work, if the two varieties bloom together; but since the three groups usually bloom at somewhat different periods there can be no general cross-pollination outside the limits of the species.

Numerous crosses and common orchard practice have also shown that the European pears, as Bartlett, and the Sand pear hybrids, as Kieffer, will fertilize each other regularly when they bloom together. Several Kieffer fruits from Bartlett pollen, and Bartlett fruits from Kieffer pollen, were secured in the crossing work of 1899. In fact, my experience has been that if Kieffer pollen is put on the pistils of our common pears, of the European class, it will usually produce larger fruit than pollen from most varieties of that type. Kieffer is a good pollenizer for Bartlett, Angouleme, Clapp, Nellis, and like varieties, when they bloom together. In Fig. 81, compare the size of the Seckels which received Kieffer pollen with those which had Lawrence pollen. The specimens shown are typical of thirty fruits secured from these two crosses in 1899.

It is necessary to study not only the mutual affinity of varieties belonging to different species, but also of varieties of the same species. Some varieties will not fertilize each other, though blossoming at the same time. Kerr has found that Whitaker plum will not fertilize Wild Goose, nor will Early Red help Caddo Chief. Again, the pollen of some varieties will give better fruit than that of others when used on the pistils of self-sterile or even on self-fertile varieties. There is very little definite knowledge as to what varieties are best adapted for pollinating self-sterile sorts. Waugh and Kerr have studied this point with native plums for several years and their judgment is united in a table of recommended pollenizers for plums (Twelfth Report Vt. Ag. Ex. Sta.). A few results from crosses made at Ithaca in 1899 will illustrate this point. Fig. 81 shows the comparative size of Seckel

when pollinated with Kieffer and with Lawrence pollen. Clapp pollinated with Kieffer was also larger than Clapp pollinated with Lawrence or Louise Bonne. Howell blossoms which received the pollen of Clapp gave fruits of nearly twice the size of those which received Bartlett pollen. Bartletts crossed with Angouleme were larger than Bartletts crossed with Sheldon. In some cases no difference could be noticed, yet most of our standard commercial varieties will be likely to yield enough better fruit when planted with some varieties than with others, to make a study of this point worth the while.

Some of the combinations which have been very successful in the commercial orchards of the country are: Bartlett with Nelis, Flemish Beauty, Easter, White Doyenne; Idaho with Bartlett; Kieffer with LeConte, Garber; Coe Golden Drop with French prune, Green Gage, Italian prune (Fellenburg); Statsuma with Abundance, Burbank, Red June; Miner with DeSoto, Forest Rose, Wild Goose; Wild Goose with DeSoto, Newman, Miner.

### DOES CROSSING CHANGE THE APPEARANCE OF THE FRUIT?

In connection with the mutual affinity of varieties which are selected for cross-pollination there comes the question of the "immediate influence" of pollen. For instance, if Seckel pollen is put on Kieffer pistils, will it impart the Seckel flavor, color and characteristic shape to the resulting fruit? Of course the characters of both may be united in the seeds, and the trees which come from these seeds may be expected to be intermediates; but is the flesh of the fruit ever changed by foreign pollen?

The increase in size which often follows crossing cannot be called a true immediate influence, for the foreign pollen generally stimulates the fruit to a better growth because it is more acceptable to the pistils, not because it carries over the size-character of the variety from which it came. In 1899, Hyslop crab pistils, which were fertilized with pollen from the great Tompkins County King, grew into fruits of the usual crab size. An immediate influence in size may be possible, for the size of the fruit is nearly as constant a varietal character as is the shape; but most of the increased size in crosses of orchard fruits probably arises from the fact that the pollen is more acceptable.

Setting aside the usual gain in size resulting from crossing, we wish to know whether there will be any change in the shape, color, quality, and season of ripening of the fruit. A few undoubted instances of this influence have been noticed with some plants in which the seed is the principal part of the fruit, as the mixing of sweet corn and field corn; also, perhaps, in various peas and beans. When the seed is surrounded by a fleshy pulp, however, as in our common orchard fruits, it is still in dispute whether this pulp is influenced, however much the seeds themselves may be. Most men have formed their convictions about the immediate influence of pollen from observation, rather than from experimental proof. It does not necessarily follow that "sweet and sour" apples are due to cross-pollination, nor that the russet on Greening apples borne on the side of the tree next a Roxbury was produced by the influence of the Roxbury pollen.

83.—LONGFIELD. From Greening pollen below; from Longfield pollen above. Marked benefit from cross-pollination.

87.—ABUNDANCE. From Abundance pollen above; from Grand Duke pollen below. Some benefit from cross-pollination.

Most of the changes in fruit which are attributed to the influence of cross-pollination are due to variation. Every bud on a tree is different in some way from every other bud on that tree, and may develop unusual characters, independent of all the other buds, according to the conditions under which it grows.

The best way to determine whether there is an immediate influence of pollen is by hand crossing. Among the forty-five different crosses which were made in 1899 with this particular point in view, not one showed any change which could be positively attributed to the influence of pollen. Even the concentrated sweetness of Seckel made no impression on the poor quality of Kieffer; nor were there any constant differences in color, shape, or season of ripening in any of the other crosses. Nearly everybody who has crossed varieties of orchard fruits has had a similar experience.

Most of the evidence supporting the theory that there is an immediate influence of pollen in the crosses of fruits comes from observation; most of the evidence against it comes from experiment. The observer, however careful, is likely to jump at conclusions; the experimenter tries to give due weight to every influence which might bear on the problem. Since many observers and a few experimenters have found what seems to be an immediate influence of pollen on fruit, we cannot doubt but that this influence is sometimes exerted. But it is certainly much less frequent than is commonly supposed.

## THE DISTRIBUTION OF THE POLLENIZERS.

Having selected a pollenizer with reference to simultaneous blooming and mutual affinity, the fruitgrower now wishes to know how many trees will be necessary to pollinate the self-sterile variety. There are three things to be considered here: The ability of the pollenizer to produce pollen, its market value, and the class of fruit to which the self-sterile variety belongs.

Varieties differ in the amount of pollen which they produce, and the pollen production of the same variety is also greatly modified by differences in locality and season. Other things being equal, the variety which produces pollen freely could be used more sparingly in a block of self-sterile trees than one of scanty pollen production. Little comparative observation has been made on this point as yet; but, as a matter of fact, most of our common varieties produce an abundance of pollen.

The number of trees of the pollenizer would also depend largely on whether it has value in itself. If we are planting LeConte to pollinate Kieffer, we would naturally try to get along with the least possible number which will do the work; but if Bartletts are to be used for the same purpose, we can afford to increase the proportion. Some growers plant every tenth row to the pollenizer, but the proportion should usually be greater. This might be enough if the weather during the blossoming season is very favorable for cross-pollination by wind and insects; but if it is showery, the pollenizers should be more abundant, in order that cross-pollination may be more general during the bright weather between showers. If using Garber

or LeConte to pollinate Kieffer, every third row may be the pollenizer; if using the Bartlett, every other row. For apples, cherries, and domestic or Japanese plums, the same proportion may be used. In a commercial orchard, the pollenizer should be planted in a solid row. Theoretically, it is much better to have the pollenizer more evenly distributed among the self-sterile trees: practically, it will not pay to so mix them, except in small orchards.

### THE ADVANTAGES OF GENERAL MIXED PLANTING.

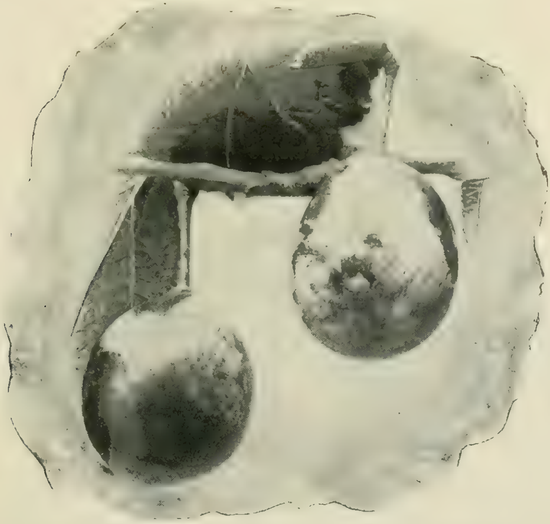
It would appear that the only thing to do now is to find out what varieties are inclined to be self-sterile and the varieties which are best adapted for fertilizing them. But as a matter of fact, cross-pollination gives better results with nearly all varieties, be they self-sterile or self-fertile. A variety may be able to bear good fruit when it is planted alone, but it will often bear better fruit if suitable varieties are near it. Mixed orchards are more productive than solid blocks, taking the country over. It is a common observation in Western New York that Baldwins in mixed orchards are more uniformly productive than Baldwins in large blocks. Furthermore, although a variety may be able to set an abundance of fruit with its own pollen, this fruit will often be smaller than if other pollen were supplied. From a number of experiments made in 1899, a few representative results are here given to illustrate this point.

Compare the size of self-pollinated and cross-pollinated fruits in Figs. 82–86. In some varieties the difference was very marked, as with Stark and Longfield apples (Figs. 82–83); in others the difference was not so marked, as Abundance (Fig. 84); while a few showed no appreciable increase in size from cross-pollination, as Talman Sweet and Bradshaw (Figs. 85–86). The difference between the cross and self-pollinated Starks and Longfields is so striking that one would almost be tempted to think the self-pollinated fruits were wormy, but they were not. The self-pollinated Talmans and Bradshaws were apparently as fine in every way as the cross-pollinated fruits. Manning Elizabeth pear also was not benefited by pollen from other varieties.

The three self-pollinated Longfields here shown (Fig. 83) had but five sound seeds: while the two crossed specimens had seventeen sound seeds. In general, cross-pollinated fruits have more good seeds than self-pollinated fruits, but there is no constant relation between the size of a fruit and the number of seeds it contains. Some of the biggest apples or pears may have only two or three good seeds. In case the ovules in one cell of an apple or pear core are not fertilized, that part of the fruit adjoining is often stunted and the fruit becomes lopsided in consequence: but this, likewise, does not always follow.

All of the above varieties are self-fertile, at least in Ithaca. They will produce fruit with their own pollen. But we have seen that some of them will produce better fruit if other pollen is supplied. Is it not worth while, then, to plant pollenizers even with self-fertile varieties — that is, to practice mixed planting with all varieties? There are three good reasons for doing this: First, some believe that self-sterility is likely to increase in the future,

85.—Talman Sweet. From Talman Sweet pollen above; from Wagener pollen below. No benefit from cross-pollination.



86.—Bradshaw Plum. From German Prune pollen above; from Bradshaw pollen below. No benefit from cross-pollination.

under the stimulus of high cultivation. Second, we can never be perfectly sure that any variety will be self-fertile on our soil and under our culture, even those varieties which are self-fertile elsewhere may be partially self-sterile with us. Third, most self-fertile as well as self-sterile varieties are benefited by cross-pollination. It is taking risks to plant a very large block of one variety. The trees may bear just as much and just as fine fruit as though other varieties were with them, but the chances are against it.

### THE POLLEN CARRIERS.

The pollen of one variety is carried to the pistils of another in two ways: By the wind and by insects. There are many kinds of insects which aid more or less in the cross-pollination of orchard fruits, principally bees, wasps, and flies. Of these, the wild bees of several species are probably the most important. In a wild thicket of plums or other fruits, they are usually numerous enough to insure a good setting of fruit. But few, if any, wild bees can live in a large orchard, especially if it is well tilled. As the extent and thoroughness of cultivation increases, the number of these natural insect aids to cross-pollination decreases: hence, it may become necessary to keep domestic honey-bees for this purpose.

### SUMMARY.

1. Scarcely one fruit blossom in ten sets fruit, even in the most favorable seasons and with the most productive varieties.
2. Trees making a very vigorous growth may drop their blossoms.
3. Brown rot, apple or pear scab, and pear blight may kill the blossoms.
4. Frost injury to blossoms is of all degrees. Even flowers which appear to be uninjured may be so weakened that they cannot set fruit.
5. Rain during the blooming season prevents the setting of fruit chiefly by destroying the vitality of the pollen, injuring the stigma, or by preventing fertilization because of the low temperature. The washing of pollen from the anthers seldom causes serious loss.
6. Much of the unsatisfactory fruiting of orchards all over the country is due to self-sterility. A tree is self-sterile if it cannot set fruit unless planted near other varieties.
7. The main cause of self-sterility is the inability of the pollen of a variety to fertilize the pistils of that variety.
8. Poor stamens and pistils, or the premature ripening of either, are but minor causes of self-sterility.
9. An indication of self-sterility is the continued dropping of young fruit from isolated trees or solid blocks of one variety.
10. Self-sterility is not a constant character with any variety. The same variety may be self-sterile in one place and nearly self-fertile in another.
11. Poorly nourished trees are more likely to be sterile with their own pollen than well-fed trees are.
12. The loss of fruit from self-sterility usually may be prevented by planting other varieties among the self-sterile trees.

13. The European and Oriental pears can fertilize each other, and many varieties of the domestic, Japanese and native plums are likewise interfertile, provided they bloom together.

14. The pollen of some varieties will give larger fruit than that of others when it falls on or is applied to the pistils of either self-sterile or self-fertile varieties.

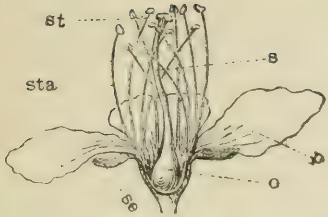
15. Among our common orchard fruits cross-pollination seldom has an immediate influence on the fruit itself.

16. Cross-pollination probably gives better results than self-pollination with nearly all varieties.

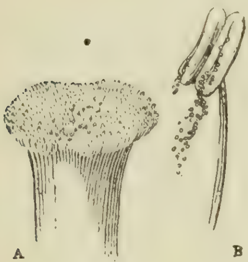
17. It is advisable and practical to plant all varieties of orchard fruits, be they self-sterile or self-fertile, with reference to cross-pollination.

18. Insects are probably more important than wind for carrying pollen from tree to tree.

19. *Final Suggestions*—a. When setting out new orchards, do not plant a solid block of each variety, but mix them intelligently. b. If established orchards are unfruitful because of self-sterility, it may be profitable to put a few grafts of another variety in each tree. c. Keep fruit trees well nourished, but do not stimulate them to an over-vigorous growth.




65.—The structure of a plum blossom. se. sepals; p. petals; sta. stamens; o. ovary; s. style; st. stigma. The pistil is comprised of the ovary, style, and stigma. It contains the female part. The stamens are tipped with anthers in which the pollen, or male part, is borne. The ovary o, ripens into the fruit.




66.—B, pollen escaping from anther. A, pollen germinating on the stigma. Enlarged. The transfer of pollen to the stigma is called pollination.

67.—Pollen grain germinating. Greatly magnified.

65–67.—Details of a fruit blossom.

68.—At 7 A. M.

69. At 10 A. M.

70.—At 3 P. M.

71.—At 8 A. M. the next morning.

68–71.—The opening of a flower of Kieffer pear. The flowers of pears and apples have five styles and stigmas. All natural size.
(Courtesy of *American Gardening.*)

# THE APPLE AND HOW TO GROW IT.

By G. B. BRACKETT, United States Pomologist.

## INTRODUCTION.

Every farmer, however small his possessions may be, who lives within the apple-growing districts of the United States, should have an apple orchard, the product of which should be found on his table in some form every day of the year. It is the purpose of this bulletin to present briefly some of the reasons why the farmers of this country should give more attention to the planting and care of their orchards; to aid them in the selection of orchard sites, of the varieties they may profitably plant, and of the trees that will prove most thrifty and productive; and to give information as to after care of orchards and the best use and disposition to be made of the fruit when grown and ready for family use or market. If this should stimulate the apple industry among our farmers, although it be only for home use, it will be a sufficient reward for the preparation and publication of this treatise.

The possible range of apple growing within the territory of the United States is very great. Perhaps two-thirds of the settled portion of our country is more or less adapted to the growth of this staple fruit, and within that range there are but few cases where the farmer is excusable if he allows his family to go hungry for apples.

## HISTORICAL NOTES.

Although the apple (*Pyrus malus*) is not a native of American soil, it seems to find a congenial home here. It is true we have some nearly related species in our native crabs, and they give promise in the hands of the experimenter of better things in the years to come, but as yet no specially valuable varieties have been developed from this source. Our cultivated apples and crabs are the lineal descendants of the wild crabs of Europe, *Pyrus malus* and *Pyrus baccata*, which have had many years of careful culture bestowed upon them to bring them to our present standard of excellence. When our American species have had as many years of domestic life and careful culture bestowed upon them they may rival their foreign cousins in many of their good qualities. In a short treatise like this, addressed, as it is, to the plain, practical farmers of our country, it may not be expected that an elaborate scientific explanation of all the methods of improving and domesticating a wild species will be presented and discussed. It is deemed sufficient, therefore, under the present heading, to say that the apple in its cultivated varieties as grown in this country is a foreigner, but, like the Caucasian race of man, has found a congenial home in the major portion of the United States and in large areas of the adjacent territory of British America.

## USES OF THE APPLE.

So well known are the uses of the apple that little need be said upon this subject. No fruit known to the cultivator in the north temperate zone can take the place of the apple as a food product. Many other fruits, indeed most cultivated fruits, rank as luxuries, but the apple in most parts of the United States is one of the leading staple products of the farm.

In its numerous varieties its season of maturity extends throughout the year. No other fruit of the temperate zone may thus be had in continuous succession without resorting to artificial means of preservation. It is pre-eminently useful in the household economy. As a culinary fruit none excels it. It graces the table in a greater variety of forms than any other, and as a dessert fruit few are its equal and none its superior. Its juice when extracted makes an excellent and wholesome beverage, and for vinegar it has no rival. As a market fruit it is one of the easiest and least expensive to handle, and usually finds a ready market if well grown and handled with that end in view.

Among the many ways in which the apple is now used, the manufacture of jellies and preserves is one of growing importance. The numerous factories for the manufacture of these goods which have sprung up all over the apple-growing region of the country have not only created a demand for second and third-grade apples, but also for the waste products—cores and skins—resulting from drying and evaporating the fruit. It has been found that jellies manufactured from this apple waste are almost as good as those manufactured from whole fruit. These waste products have not only a value for the uses above mentioned, but there is a growing demand for them for export purposes for the manufacture of cheap wines and cider.

Chops, for which there is also ready sale for export purposes, are made from the lower-grade apples by chopping the whole fruit into coarse pieces and converting by an evaporator into what is known as chops.

Apple butter, of the real, rich, old-time farm product, not the thin, factory-made excuse, fills an important place in the household economy and always finds a ready sale at good prices.

Good, sweet cider, made from sound apples, not from half-decayed, wormy fruit, is one of the most healthful products of the orchard, and all surplus over and above what is needed for home consumption is always in demand at remunerative prices. It can be kept sweet and unfermented by heating it to a temperature of 160° F. and holding it there for thirty minutes, then sealing it up tight in bottles or casks, to be put into a cool place.

Boiled cider made in the good old-fashioned way by reducing to one-fifth by boiling, and canned, makes an excellent article for culinary purposes, for making apple butter, apple sauce, or for use in apple or mince pies. It also has a commercial value.

While the aim and purpose of the farmer should be to supply an abundance of fruit for his own family, he should also be able to offer to the outside world a liberal surplus. The apple orchard will often bring him better returns for his outlay than any other portion of his farm, acre for acre. The product of a single tree will sometimes sell for $10 or more, and fifty such

trees can be grown on an acre of land. Though we may not always count on such large results, we may safely expect the orchard to do its full duty one year with another, especially if we first do our duty by it.

### PROPAGATION.

We would not recommend the average farmer to propagate his own trees for planting, but it is well enough for him to understand something of the processes and methods of propagation commonly practiced. The natural method of propagation is by planting the seed of the fruit, but as a very large per cent. of seedlings are inferior in quality to the parent variety, the results are too uncertain to recommend for planters generally. Only the painstaking experimenter, who wishes to originate new varieties, can afford to practice this natural method of propagation.

Once having obtained a valuable variety and wishing to multiply and perpetuate it, one of several methods now in use must be resorted to for propagation. The methods more commonly practiced in growing young apple trees for planting in orchards are budding and grafting.

### BUDDING.

With the apple this operation must be performed during the growing season, and consists in removing a bud from a twig of the variety which we wish to propagate and inserting it beneath the bark of the stock or young seedling tree we wish to change; and this is then held in place by tying it fast until the bud and the stock have united. Then by forcing the sap and consequent growth into this transplanted bud by preventing all other growth, we get a new tree of the desired variety. This we call budding. It is a method of artificially multiplying a desirable variety. The extent of this multiplication is limited only by the number of buds available. A budding knife and the successive stages of budding are shown in Fig. 1.

The main requisite for success in budding is a healthy, growing condition of the stock on which the work is to be done, and a certain state of maturity of the buds. The bark of the stock must separate freely, so that the bud may be forced under it without injury to the cambium layer of either bud or stock. The bud sticks or scions selected for summer-budding should be of the current year's growth and should have well-developed buds. When taken from the tree the leaves must be cut off immediately, leaving only a short stub of the leaf stem for convenience in handling during the operation. (Fig. 1, *b*). They should be kept in a fresh condition by use of damp moss or wet cloth until using, and not more than one or two scions should be withdrawn from the package at a time.

*June budding*—If it is desired to start the bud into growth the same season it is inserted, the budding should be done as early in the season as well-developed buds can be obtained. As soon as it is found that the bud has united with the stock or branch, the material used to fasten the bud in place must be removed and the stock or branch cut back to within a short distance from the bud, to force the growth of the inserted bud.

*Late fall budding*—This is the kind of budding more commonly practiced among nurserymen, the buds being inserted into the stock as late in the season as the bark of the stock will separate freely to receive it. In such instances the bud remains dormant through the following winter. The following spring the wrapping is removed and wherever the buds appear sound the tops of the stocks are cut back and treated in the same manner as described for June budding. All buds on the stocks below the one inserted should be rubbed off as they start to grow. The objection to early, or June, budding is that the growth from such buds does not always mature sufficiently in northern sections to pass a severely cold winter without injury.

GRAFTING.

Grafting, unlike budding, is usually performed during the dormant period of growth. It is performed by carefully fitting a small dormant twig or scion of the variety we wish to propagate into a cut in a stock or seedling tree which we wish to change. There are several forms of grafting, but they differ more in method than in results. In fact, so far as the top of the tree is concerned the results are the same in all cases, whether we bud or graft. The object sought is to change an undesirable or uncertain tree into one which we know will produce a certain variety whose fruit will possess certain desirable characteristics.

*Splice grafting*—This is a simple form and is used when the stock and scion are very nearly the same size. It consists in splicing or lapping the scion on the stock by scarfing each at the same angle. (Fig. 2, *a*). When a close joint is secured the parts are held in place by means of some kind of wrapping material. (Fig. 2, *d*).

*Tongue grafting*—This form differs from splice-grafting in that both scion and stock are split at corresponding points on the scarf with a thin-bladed knife so as to form tongues as represented in Fig. 2, *b* and *c*. The object of this is to unite more firmly the two portions and present a larger surface for the effusion of cell tissue, and to promote the callusing process. This is the method commonly practiced by nurserymen under the name of root-grafting.

*Root-grafting*—Thrifty one-year-old stocks grown from seed are taken up in the fall, and stored in a cellar or buried in the soil, where they will keep fresh and be accessible at any time when wanted. The scions having been secured in the fall, the work of grafting may be performed at any time during the winter. The roots only are used in this method, and they may be cut in two or more sections according to their size and length or the desire of the propagator. But the larger or stronger roots as a rule may be relied upon for the most satisfactory results.

In the foregoing methods of grafting, but especially in the first, the parts must be held together by some kind of bandage or tie. This may be made of thin cotton cloth or tough manila paper spread with melted grafting wax, and, when cool, cut or torn in narrow strips of convenient width for wrapping, as described in formula No. 1 for grafting wax (p. 214). But the most common method now practiced is in using cotton yarn drawn through melted wax and wound upon a spool, from which it is used when wanted (Fig. 3).

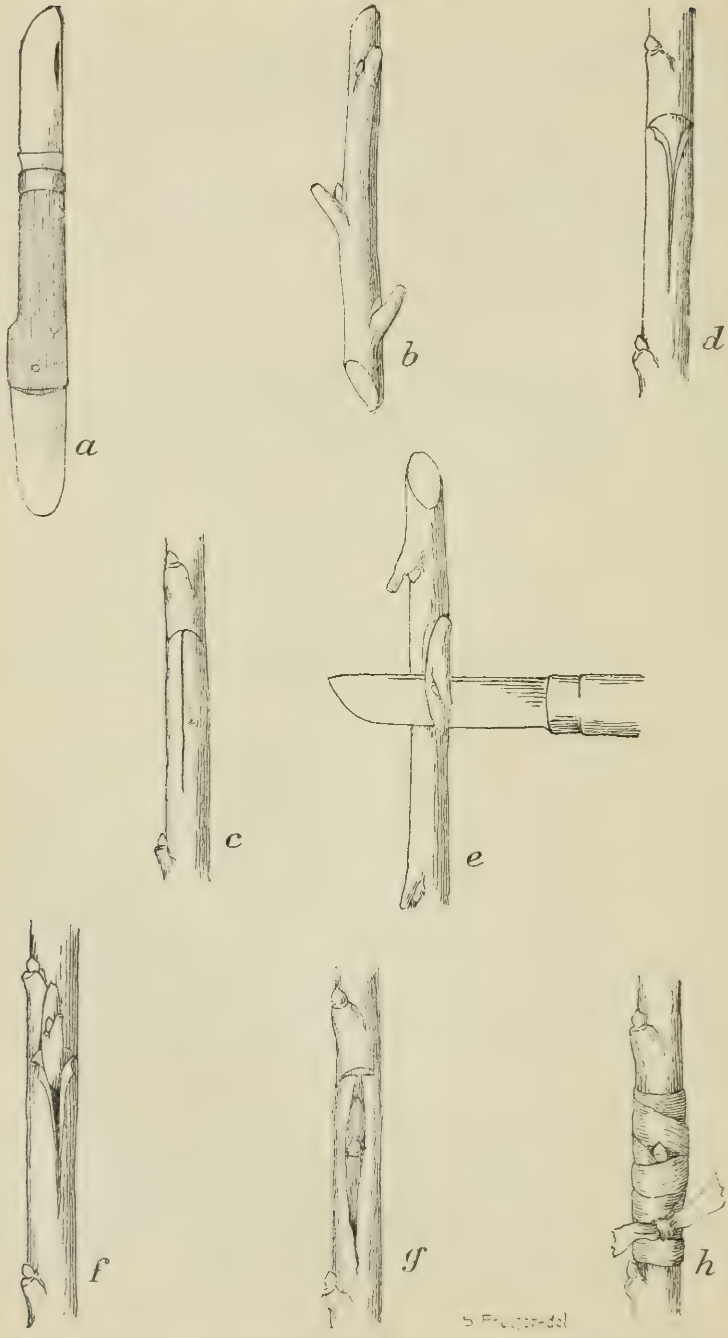



FIG. 1.—Budding: *a*, budding knife; *b*, bud stick; *c*, incision lengthwise with cross at top; *d*, opening of bark for insertion of bud; *e*, removing the bud; *f*, inserting the bud; *g*, bud inserted; *h*, tying in the bud.

These root-grafts, after having been tied in bundles, with each variety separately labeled, may be packed away in moist earth or loam and left in the cellar free from frost until spring, when they should be planted in nursery rows in the open ground and cultivated for one, two, or three years, when they are ready to be transplanted to the orchard site.

Thorough cultivation in the nursery rows should be given, and some attention should be paid to training or shaping the young trees, so as to insure the best results when transplanted in the orchard.

*Cleft-Grafting*—Cleft-grafting is generally done when the stock is considerably larger than the scion and where the operation is to be performed above ground. The stock is split downward, after it has been cut off at the point where the scion is to be inserted, by using a fine-tooth saw. The bark should be cut through first to avoid being torn and so that the sides of the cleft will

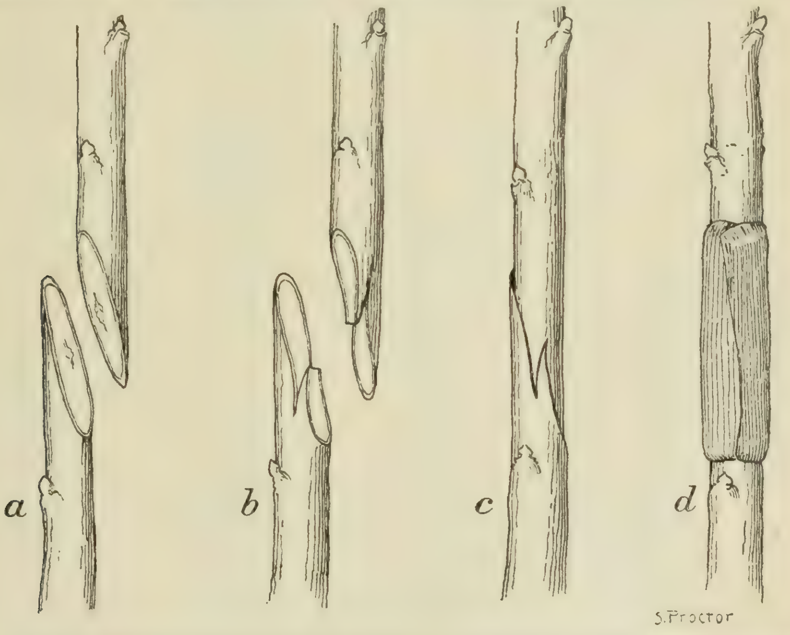



FIG. 2.—Successive steps of stock grafting; *a*, splice graft; *b*, tongue graft, separate parts; *c*, tongue graft, parts united; *d*, wax applied.

be smooth. A wedge is inserted to keep the cleft open for the insertion of the scion, which is cut wedge shape, with a long slope, one edge being a little thicker than the other (Fig. 4). The object of this is to have the pressure of the cleft greatest upon the outer side where the union is to be effected.

If the stock is large enough, a graft may be inserted on each side of the cleft, and if both grow one should eventually be cut off. After the scions have been properly inserted the wedge should be carefully withdrawn,

leaving the scion in place, so that the inner bark of the scion and the stock shall coincide. If the pressure of the cleft be not sufficient to hold the scion in place, it must be wrapped with cloth or strings before waxing.

It is now ready for the grafting wax, which may be applied either in liquid form with a brush, or in plastic condition after having been worked with the

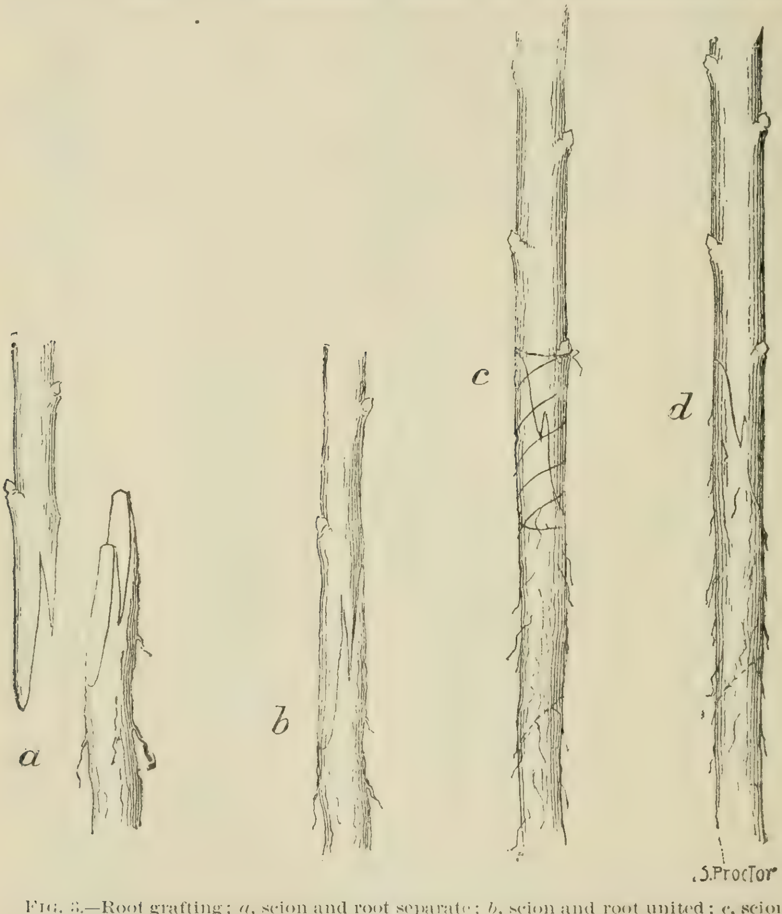



FIG. 3.—Root grafting; *a*, scion and root separate; *b*, scion and root united; *c*, scion and root united and tied; *d*, united scion and root with dotted line showing where root may be divided.

hands, or sometimes by wrapping with strips of muslin or manila paper previously spread with wax, as mentioned above. Great care should be taken to make every joint airtight or the operation will be a failure.

REGRAFTING BEARING TREES.

This is sometimes very desirable when it is found after trees have come into bearing that the fruit is worthless. When the trees are not too old, and

are in a healthy condition, the change can be made by regrafting with good results. But when the trees have attained a considerable age, and have lost their vitality to a considerable extent, it would be a waste of time and expense to attempt to change them: better plant new trees. If, however, in the case of healthy, vigorous trees, it is considered advisable to regraft tops, it is not best to do this all at one time. Only about one-third of the tree should be grafted the first year, selecting branches in the center and top of the tree. The next year another third may be grafted, and the remainder the following year.

FORMULAS FOR GRAFTING WAX.

*Formula No. 1, for outdoor work.* Resin four or five parts, beeswax one and one-half to two parts, linseed oil one to one and one-half parts. This is melted in a mass, and when cool enough, it may be drawn out into thin strips and applied by wrapping it firmly around the stock where the scion is in-

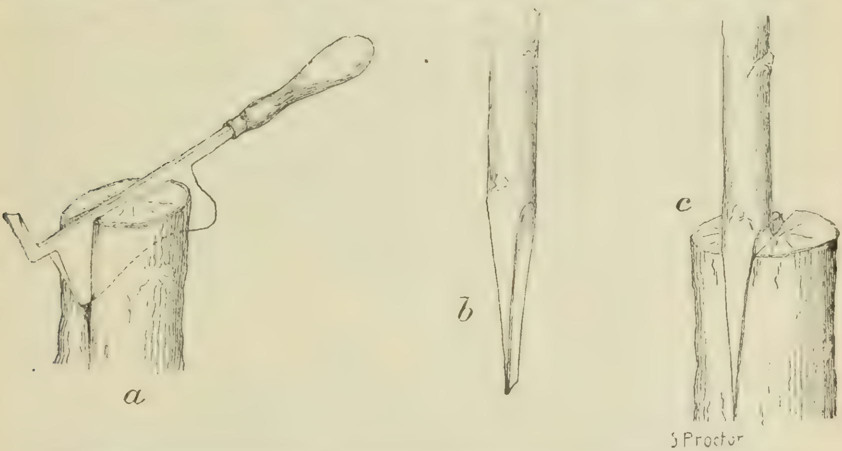



FIG. 4.—Cleft grafting; *a*, splitting the stock; *b*, scion prepared for insertion; *c*, scion inserted.

serted: or a more convenient mode of using this wax is to spread it while melted upon thin muslin or strong manila paper, and when cool cut or tear in strips of convenient width for wrapping around the grafted stock.

*Formula No. 2, for indoor and outdoor work.* Resin six pounds, beeswax one pound, linseed oil one pint. Melt together, and when at the temperature of 180°, apply directly to the joints with a small bristle brush. In order to keep it at the proper consistency, the vessel containing the wax may be placed in another vessel containing boiling water, which may be kept at this temperature by any convenient application of artificial heat.

LOCATING AN ORCHARD.

The selection of an orchard site is not governed by any arbitrary rule. All farms do not afford the best soils and exposures for orchards. The

owners of such as do not are unfortunate, yet they should not feel discouraged to the extent of not planting trees and caring for them afterwards.

### EXPOSURE.

Some kinds of soils and surface presentations are preferable to others, as they are better adapted to this fruit and require less expense in preparation and in the after care and treatment of the orchard. The most intelligent and experienced orchardists often differ as to the best location and exposure of an orchard, some preferring a nothern slope, others an eastern, and yet others recommend a southern, or even a western as best. We think, however, that the advantages preponderate in favor of a gentle eastern or northeastern slope, as orchards located on such sites suffer less in both soil and tree from the effects of heat and drought. An orchard with such an exposure will maintain its vigor and longevity better than if inclined to the west or southwest. This is especially true in states south of the New England group, where the summers are long, hot and dry, and where it is probable that the greatest injury to trees results from these causes. But, as stated above, all farms do not afford these most favorable sites, especially near the home, which is the most desirable location for the family orchard. Thus, the planter will often be forced to forego such a location, and take his chances where the natural conditions are not so favorable. If possible, the site should be elevated above its immediate surroundings, thus giving a free circulation of air: and it will also be of great aid in guarding against late spring frosts, so fatal to young fruit at the blooming season.

### SOILS.

Apple trees will thrive and do well on almost any soil well prepared, but the different kinds of soil may require different treatment and after care.

*Loamy Soil*—A loamy soil is naturally rich in plant food, hence will need little, if any, manuring in its preparation: but it should be deeply stirred and thoroughly broken up by subsoiling. This loamy soil is what may be termed free soil, as it seldom becomes compacted, even by abusive treatment.

*Clay Soil*—A clay soil is the most difficult to prepare, and often requires manuring, as well as thorough plowing, replowing, and subsoiling. It should be also frequently stirred during the summer months, and especially as soon after each rain as is practical, to prevent it from baking and becoming compacted. This becomes even more important in seasons of long and continued droughts.

*Sandy Soil*—Sandy soils are generally lacking in necessary plant food. They also have the objection of losing such fertilizers as may be added by the leaching of the rainfall.

*Effects of Several Soils*—The wood-growth on loamy soils will be strong and vigorous, but may not be sufficiently mature to withstand the freezing of the more rigorous winters. Clay lands are not so apt to produce such vigorous growth, and orchard trees on such lands will be hardier as to win-

ter-killing than are most other soils. With a free subsoil underlying it, a loamy clay soil will probably yield the best results, especially if it be well prepared by thorough culture and subsoiling before planting the trees. Timber lands, or lands on which forests have formerly grown, if having the proper exposure and drainage, are preferable for orchard sites. Such lands contain all the elements of plant food necessary to insure a good and sufficient wood-growth and fruitfulness. Fruit grown on such lands will rank first class in size, quantity and appearance.

### DRAINAGE.

All orchard lands should be thoroughly surface-drained and subdrained. No orchard can endure for a great length of time with stagnant water either on the surface or within the soil. All surplus water from excessive rainfall, or from other causes, should be promptly removed by either surface or subdrainage.

If the natural formation of the land does not afford such prompt drainage it must be provided artificially. Surface ditches or furrows between the rows of trees may afford temporary drainage, but they are objectionable on other accounts that will be apparent: for an orchard thus drained will be bad to get over in its necessary care and in gathering and handling the fruit. Subdrainage is far better on these accounts; besides, it is much more thorough, especially if supplied with well-laid tile.

A thorough breaking up of the subsoil will afford temporary drainage in a stiff clay soil, but in a few years the soil will again become compacted, when it will require restirring. But in all cases the planter should be the judge of the special requirements of his soil and location as to drainage, etc.

### USE OF FERTILIZERS AND OF CLOVER.

The soil constituting the proposed orchard-site should be carefully studied, and if found to be lacking in essential elements of fertility naturally to maintain a fairly vigorous wood-growth, fertilizers should be added before plowing, that they may become thoroughly incorporated with the soil in preparing the land for planting.

### BARNYARD MANURE AND WOOD ASHES.

Scientists and practical orchardists are generally agreed on the great value of well-rotted barnyard manure as the best for an apple orchard. It not only supplies humus, but it contains a large per cent. of other necessary nutritive elements for maintaining health, vigor, and fruitfulness of tree and development of qualities for a fine fruit product. But as the stock of this sort of manure is not always sufficient for the general demand, other agents have to be resorted to; and, next in value, and in a concentrated form, are unleached wood ashes, which will supply to a great extent the necessary element of plant growth. It is mantained by some authorities that one ton of

unleached ashes contains as much plant nutriment as five tons of ordinary barn manure, and, whenever obtainable, ashes should be used in preference to any other fertilizer.

### MANUFACTURED FERTILIZERS

There are many kinds of manufactured fertilizers, some of which are valuable for special soils, but to determine just what brand to use is a difficult question to decide without knowing what elements are lacking in the soil. The three elements most commonly deficient in soil are nitrogen, potash, and phosphoric acid, and chemical fertilizers that contain the largest per cent. of these substances will be the most economical and beneficial.

A fertilizer containing one and one-half to two per cent. of nitrogen, seven to nine per cent. of available phosphoric acid, ten to twelve per cent. of potash, will give excellent results when applied to orchard land in quantity ranging from four hundred to six hundred pounds per acre.

### GROWING OF CLOVERS.

Western prairie lands are generally sufficiently fertile for an orchard growth, and need no enriching until the trees begin to show signs of weakness in vigor from crop-bearing, and, even then, may be invigorated by use of crops of red or crimson clover grown among the trees, allowing the crop to fall and decay upon the ground each year. By this treatment a large amount of decaying vegetable matter will accumulate upon the land, rich in plant food and forming a moist protection from hot summer sun and deep freezing during winter, a condition conducive to health and vigor in tree. All lands lacking in humus can have this element restored to a great extent by such treatment, and orchards which have been treated thus with red clover maintain greater longevity, fruitfulness, and greater excellence in fruit product, besides such treatment dispenses with the costly necessity of using special fertilizers.

### SIGN OF NEED OF MANURE AND CULTIVATION.

As to the indications when a bearing orchard needs stimulating, the eminent pomologist, Doctor Warder, once said: "When the growth of the terminal branches fails to make an annual extension of at least one foot in length, the tree should be stimulated by manuring the land and giving it thorough cultivation."

### PREPARING THE LAND FOR PLANTING.

The general work of preparing the land for planting an orchard consists in deep tilth, and the more thoroughly it is done the more certain is success. The preparation had best be done late in the fall, when it will be ready for early spring planting, or for fall planting if preferred. Many successful orchardists, especially in the western states, prepare the land by opening

with a heavy plow a furrow where the rows of trees are to be set and then back furrowing the space between them, making a land section with a tree row in the center. This method affords a deeper tilth under the trees, and, at the same time, surface-drainage into the opening and finishing furrow midway between the rows, which will receive, and if properly graded, carry off any surplus water which may accumulate from heavy rainfalls.

### DISTANCES FOR PLANTING.

A decision as to the proper distance apart to set trees varies with different plantings. Some plant sixteen by thirty-two feet—that is, the rows one way are thirty-two feet apart. The object of this method is to obtain a crop from the trees until they begin to interfere with each other, when every alternate tree in the row is cut out, leaving the trees in the entire orchard at a distance of thirty-two feet each way. The trees to be cut out should be early-bearing, short-lived varieties. This system has the advantage of utilizing the land between the rows, which becomes a source of great fruit product before the thinning out becomes necessary.

Other planters adopt a distance between trees of twenty, twenty-four, and thirty feet apart each way, claiming that by the time the trees interfere with each other they will have finished their growth and the orchard will begin to decline. But it is generally conceded that thirty-two to forty feet is the preferred standard distance. If the distance of forty feet each way is adopted, it will afford ample space between the rows for growing any crop which requires cultivation, such as corn, beans, potatoes, etc. Such cultivation is highly important and necessary for the maintenance of moisture in the soil and to the health and vigor of the trees. This distance will afford free circulation of air and abundance of sunlight, both of which are essential to the growing of well-developed and highly-colored fruit. As stated elsewhere, small grain should never be grown among fruit trees, especially when the orchard is young.

### SEASON FOR PLANTING.

This question is governed somewhat by latitudes. In southern latitudes late fall or the early part of the winter may be safe for planting. But in most of the states early spring is considered the better time. Fall planting has the objection against it that the roots of a tree do not take hold of the ground sufficiently to supply enough moisture to maintain a healthy, active circulation of the sap, which is required to prevent shriveling of the branches during winter's extreme cold and exhaustive evaporation from drying winds.

### SELECTION OF TREES.

This is a very important part of orcharding, for upon care and judgment in the selection of trees depend largely future profits of the investment. Strong, stocky, and vigorous one or two-year-old trees, called whips by nurserymen, having well-developed root systems, are preferable. Trees of

this type and age are more satisfactory and profitable in time, and suffer less in transplanting, cost less, and are much more easily handled than older ones.

In this connection we would suggest the advisability of purchasing trees for planting from the nearest responsible nurserymen. The local nurseryman, if perfectly familiar with his business, will understand the needs and demands of his home customers and should grow the varieties best suited to his section of country. If honest he should feel himself morally if not legally responsible for the correctness of his nomenclature. By securing trees at the near-by nursery all danger from damage by long transit and injurious effects of sunshine and frost are avoided; besides, if the farmer makes his purchase direct from the nurseryman, he will save expense of middleman or agent, and is less liable to the mistakes and injury that may occur through repeated handling.

VARIETIES.

Owing to the greatly diversified soil and climatic conditions that exist throughout the territory of the United States, it would not be safe to attempt to give more than general advice on the subject of varieties to plant. Among the very extended list of cultivated varieties of merit, there are few, if any, sections where the apple will grow that varieties may not be found that will give satisfaction if they have a fair trial. But it is a well-known fact that but few of these can be safely recommended for a special locality. There are certain varieties that have a wider range of adaptability than others. Instances of this character may be found in the Ben Davis variety, which has a wide range of adaptability, while the success of the Yellow Newtown or Albermarle is confined to a few localities.

Then, again, a variety may succeed in widely separated regions, while in the intervening sections it may be an entire failure. This fact is well established in the case of the Yellow Newtown, that reaches its highest state of perfection in certain sections of the Pacific Coast fruit regions and in the Piedmont sections of Virginia and North Carolina, while in most of the widely diversified but intervening territory it is nearly worthless.

*Local conditions as affecting choice of varieties*—With these facts before the reader he will readily see how unwise it would be to attempt to offer in this connection other than general advice on the subject. A comparatively safe guide for the planter to follow or to be governed by is to study well his immediate environs and to take counsel of those of his neighbors who have had practical experience in growing varieties on soils and exposures quite similar to his own. In this way he may be able to obtain valuable information in regard to varieties that have been tested and found to succeed in his neighborhood.

*Present demand as affecting choice of varieties*—In the pioneer days of fruit culture, especially in the Mississippi Valley section of our country, the great aim and object of the enterprising planter seems to have been to secure and plant all of the numerous varieties within his reach without considering the question of adaptability of the variety to the conditions of soil and climate. For a time, at least, while the soil was new and diseases and

insects less numerous, his efforts gave fairly satisfactory results. Now, however, conditions have changed and many of the sorts that were once popular and profitable are considered valueless. So that, notwithstanding the list of desirable varieties is greatly increased, growers find themselves compelled to study more carefully the adaptability of the varieties suited to their special conditions and purposes.

*Need of succession as affecting selection.* In making up a list of varieties for a family orchard, it is highly important to select such as will ripen in succession, so as to furnish the family with fruit throughout the entire year. This can be readily done by planting the early-ripening sorts, followed by late summer, fall, and long-keeping winter varieties.

## PLANTING.

The land having been prepare by plowing, and manured when needed, the lines to guide the planter may be marked off with a plow run deeply, opening a furrow in the direction that will afford drainage, into which the trees may be set without digging holes, especially if in clay land, which would form basins that would retain water too long after a heavy rainfall.

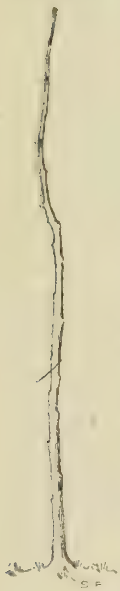


Fig. 5.—One-year-old tree with line showing where to cut back

### DETAILS OF SETTING THE YOUNG TREES.

The work of planting is made comparatively easy by the method recommended in the foregoing, viz, by the opening of a furrow with a plow for the rows, and cross-checking to indicate the point at which to set the trees. When planting, cut back the top (Fig. 5) to a point where the future head is to be formed, smooth off the ends of all the bruised and broken roots, then set, at the point in the row indicated by the cross-check, straighten the roots out into a natural position, and fill in among them, firmly, fine dirt, and tramp all down with the foot. It is best to set the tree a little deeper than when in the nursery, and leaning slightly to the south or southwest, to brace them against prevailing winds. By this position the tops will soon shade and protect the bodies from the intense heat of the summer sun, which is liable to cause sun scald. After the planting of the orchard is completed, the open furrows between the trees may be filled up by plowing one or more furrows against the row. The second year the young shoots must usually be cut back again. (See Fig. 6.)

Fig. 6.—Two-year-old tree with lines to show where to cut back.

### LOSSES BY LACK OF CARE.

In connection with this subject it is desired to lay special stress upon the importance of performing all operations of the management and care of an orchard in a painstaking way. It is worse than time and money squandered to purchase trees, transplant them, and then neglect them afterwards in such manner as to lose them entirely, and yet this is the result in a very large majority of cases. It has been estimated that scarcely more than ten per cent. of the trees that are grown and sold by nurserymen survive the after ordeal to which they are subjected before reaching the bearing age. And this great loss is very largely the result of carelessness and neglect of the planters. The farmer who does not propose to give the same careful treatment to his orchard that he does to his other crops had better not make the effort to have one. If he expects to sow his young trees to grass or small grain and then to graze it with calves or other livestock he will find other and cheaper methods of occupying his land and feeding his stock than by investing in trees. Better save his money and pains and wisely decide in advance to go without an orchard.

### CULTURE.

Thorough and oft-repeated stirring of the soil is absolutely essential to success. Such culture as is needed to produce a first-class crop of corn or potatoes will keep an orchard in good health and vigor, provided the ground is sufficiently fertile. As already stated, in no case should small grain or grass be grown in an orchard. This mistake is often made by thoughtless or inexperienced planters.

The ground having been properly prepared before planting, a two-horse cultivator frequently run between the rows will keep it in good condition during growing season. Each spring the surface should be well stirred with a two-horse plow, using a short singletree next to the row of trees to avoid danger of bruising the trunks of the trees. In plowing, the furrows should be alternately turned toward and from the trees. Such culture should be continued from year to year, at least until trees come into full fruiting, and even then it is questionable whether it should be discontinued. If it should be, red or crimson clover is the only crop allowable, and that should be turned under as often as once in every two years. As a rule, continuous cultivation gives the most satisactory results.

### PRUNING AND TRAINING.

Pruning and training are requisites in the successful management of an apple orchard. The objects to be attained are: First, symmetrical and evenly-balanced heads; second, to admit sunlight and free circulation of air into all parts of the treetop and yet maintain sufficient density of foliage to protect the trunks, branches, and fruit from the direct inntese heat of the sun's rays, which is liable to scald and injure both tree and fruit.

Training should begin in the nursery row by removing or preventing all unnecessary growth, which may be done by rubbing off the buds or

pinching back with thumb nail the tender shoots, with a view to form a straight, clean leader from the ground up, from which to form the future trunk.

SHAPING THE TREE.

As recommended under the head of planting, this single stem, if it has attained a sufficient growth, should be cut back at the age of one or two years to the height from the ground it is proposed to form the head of the tree when set in the orchard. This cutting back will cause several of the upper buds to break and grow, thus starting the top or head at proper height; and these buds should be watched, and only such left to grow as are to form the main branches. Those left should be the strongest shoots, at equal distances apart around the stem, and should tend to an outward growth—to spread and make an open head.

Fig. 7—Vase form of top.

In all pruning, to give the desired form to the head, and especially while the tree is young, the orchardist should keep clearly fixed in his mind the future form of tree—that is, what it should be when old; for what may seem an open head when young may prove, when the trees are older, to be too dense and crowded, the branches too closely formed together for convenience in getting around it in gathering the fruit or in giving necessary pruning.

During early springtime, or even late winter for convenience, when the wood is not frozen each year, every tree should be carefully looked over, and all branches which are liable to interfere with adjoining ones should be cut out and the centers of the dense growth thinned out, side branches which are making a stronger growth than the others should be checked by heading in the terminal or central shoots, and all parts of the tree should be cut back whenever needed to maintain an evenly balanced head. Some varieties

have an upright habit of growth, and some make slender growth; such need close attention each year in cutting back one-half of last year's wood-growth, leaving the top bud on the side of the branch facing the direction to which it is intended to divert the growth. By this treatment there will be no difficulty in shaping the tree into any desired form. Open spaces in the tree may be closed up; as, for instance, when the tree has been deprived of a necessary branch by accident or otherwise, the loss may be recovered in time by pruning the adjoining branches so as to divert the growth into the portion made bare of branches.

All pruning and training possible should be done while the trees are young, the growth of wood tender, as the healing over is more rapid and complete and the trees suffer less injury by the operation. If ever it becomes necessary to remove a large branch, the wound should be covered with grafting wax, paint, or some other substance that will prevent evaporation, and the wood from checking and consequent decay.

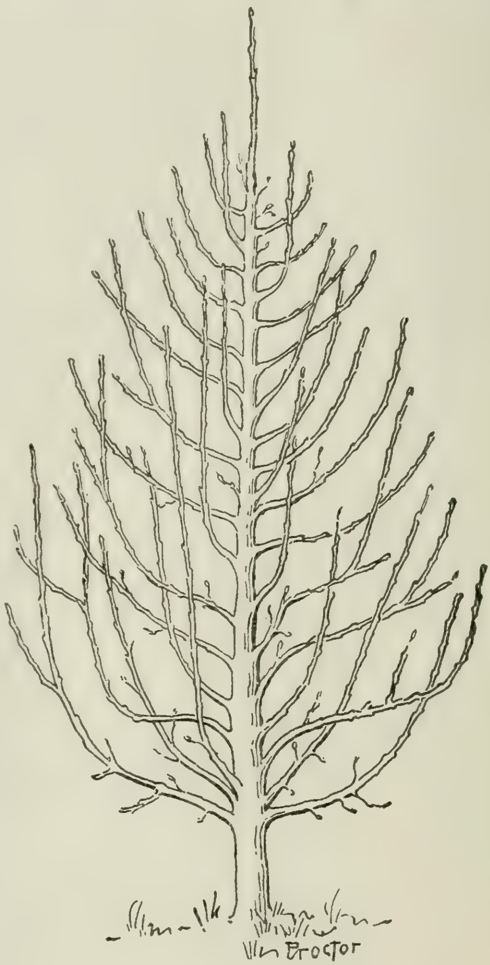


Fig. 8—Pyramidal form of top.

*Height of top*—There is a diversity of opinion among orchardists as to the proper height at which to form the top or head of an apple tree. Formerly from four to five feet high was the common practice of training apple trees, but two to three is now conceded to be preferable.

The objection to low-headed trees on account of the difficulty in cultivating the land has been overcome by practical experience. A careful teamster will do less damage to a low-headed tree than to one with a high top. With the improved implements now in use thorough tillage can be performed

as well among low-headed trees as with higher. There is less danger from high winds with the low-heads, and pruning can be performed with greater facility and ease, and the saving in expense of gathering the fruit is quite an item ; but the most important advantage gained by the low head is the protection of the body of the tree from the rays of the sun, causing what is known as sun-scald, which is very prevalent in some sections of the apple-growing region.

Fig. 9—Intermediate form of tree; proper shape.

Another point gained by the low head is in conservation of moisture and lower temperature around the base of the tree.

No arbitrary rule, however, should be laid down as to the height of a fruit tree. This may depend upon the locality, exposure, variety, and the desire of the planter.

Some varieties have an upright habit of growth, while others have a drooping or horizontal habit, each requiring a training according to its requirements ; but whatever difference of opinion there may be on this subject, it is now generally conceded that the low top, all things considered, is preferable.

*Form of top*—There are three forms that are generally adopted in this country. One known as the vase or goblet form. This form prevails to a large extent in the Pacific Coast region, where by long experience it has been found to be best suited to the conditions of that section. This form is obtained by cutting out the central stock or leader and training by a system of pruning into the shape shown in Fig. 7.

The pyramidal form is the opposite of the vase form in that the main stock or leading shoot of the tree is allowed to maintain its upright growth and the side branches are shortened back so as to produce the form of a pyramid, as shown in Fig. 8. There is, however, a modified form between the vase and the pyramid which gives a round, symmetrical shape to the tree (Fig. 9) sufficiently open to allow of free circulation of air and sunlight. This form is more generally adopted and gives better satisfaction throughout the central and eastern apple-growing regions.

# APPLE GROWING FOR PROFIT.

By H. B. MILLER, Eugene.

Apple growing in Southern Oregon is becoming one of the leading industries. It has passed through all of the experimental stages, and is permanently established on a profitable basis.

The principal apple-growing district of Southern Oregon is in Douglas, Josephine, and Jackson counties, in the valleys of the Umpqua and Rogue rivers and their tributaries. As these valleys have conditions of soil and climate nearly alike, so far as apple production is concerned, they may be treated as one section. There are many important points of difference between these localities and other parts of Western Oregon in the matter of apple growing, so this area constitutes an apple belt of its own, clearly different from others on the coast. While there are some varieties even between the valleys of the Umpqua and Rogue rivers, they are both equally good for the production of winter apples, and the variations need be taken in account only in the selection of varieties.

The cost of planting and caring for an apple orchard, and the profit it will yield, are matters worthy of careful consideration. Good apple land can be bought for $60 per acre. Other items of outlay are: Seventy trees, $5 per acre; preparing ground and planting, $5 per acre; care of trees at $10 annually for six years, $60; total cost of orchard, $130 per acre at six years.

Crops grown between trees up to four years old should pay interest on this investment. The trees might bear a crop at six years from planting: in fact I have known some varieties to produce two bushels to the tree at six years, but it is not a fair calculation to count on a crop before seven years, and with some varieties and localities I have observed that they will not bear before twelve years old. These are matters that should be examined into before planting.

A safe calculation of production and profit after the bearing period begins is as follows:

| | | |
|---|---|---|
| At seven years, two boxes of marketable fruit from each tree, one hundred and forty boxes at forty cents per box on the tree | $ 56 00 | |
| Cost of cultivating, trimming, and spraying | 15 00 | |
| Net per acre | | $ 41 00 |

COUNTING CROP EVERY SECOND YEAR.

| | | |
|---|---|---|
| At nine years old, three boxes per tree, two hundred and ten boxes at forty cents | $ 84 00 | |
| Expense for two years | 30 00 | |
| Net per acre | | $ 54 00 |
| Or for each year per acre | | 27 00 |

| | | |
|---|---|---|
| At eleven years old, four boxes per tree, two hundred and eighty boxes at forty cents | $112 00 | |
| Expense for two years | 40 00 | |
| Net for two years | | $ 72 00 |
| Or for each year per acre | | 36 00 |
| At thirteen years old, six boxes per tree, four hundred and twenty boxes at forty cents | $168 00 | |
| Expense for two years | 50 00 | |
| Net for two years | | $118 00 |
| Or each year per acre | | 59 00 |
| At fifteen years old, eight boxes per tree, five hundred and sixty boxes at forty cents | $224 00 | |
| Expenses for two years per acre | 60 00 | |
| Net for two years per acre | | $164 00 |
| Or for each year per acre | | 82 00 |

After the trees are fifteen years old the net profit is not likely to increase much, although if planted on the best soil the quantity should increase for several years. These are very conservative figures, and represent the average profit line. I know of several orchards producing a profit of from $30 to $40 per acre at six years old, and $75 to $100 per acre at seven years old, and $40 to $50 an acre again at eight years, and then again I have known orchards not to produce a cent of profit until they were twelve years old.

In apple growing, as in all other industries, there is a no-profit line all the time for a certain class of producers. Those who have the knowledge and skill to select suitable land and varieties adapted to the soil, climate and market conditions, and who are dilligent and painstaking in production, will reap a profit, while those who select improper varieties or soil, or those who neglect to take care of their orchards in any way, will be on the marginal cost of production that gives no profit. It is a great mistake to imagine that all men will make a profit in apple growing, or that the business is sure to yield a profit, regardless of the man engaged in it.

Southern Oregon has special advantages in the production of apples that will surely make it a great field of horticulture. It is as regular in its crop production as any apple section in the world: the absence of winds and destructive storms, the regularity of its rainfall and uniformity of its seasons, the climatic conditions that exempt trees from injury by freezing, and prevent injury to fruit by fungus; the abundance of lime and potash in the soils, all tend to make it an ideal locality for the production of a high-class apple.

The old home orchards, from which the markets have heretofore been supplied, must give way to the commercial orchard, and the great increase in apple consumption that will come to the Pacific Coast from the islands of the Pacific Ocean and Asia, will make a strong market in the future for the Oregon apple. Whoever enters this field of production must understand that, if he succeeds, he will have full use for his best intellectual and physical energies.

# TOP-GRAFTING APPLE TREES.

By Prof. G. Harold Powell.

Progressive apple growers are beginning to pay more attention to some of the finer problems of apple culture, such as the relation of varieties to pollination, their susceptibility to disease, the relative hardness of stocks, the individuality of trees, and the careful selection of buds for propagation. Incidental to the discussion of some of these latter subjects, a good deal is heard nowadays about the top-working of apple trees. So far as the operation pertains to unprofitable trees that are to be reworked with more desirable kinds, the discussion is not new. But top-working the young orchard after the trees have become thoroughly established, has other ends in view.

## TOP WORKING YOUNG APPLE TREES.

A few apple growers are planting a hardy, straight, vigorous-growing variety as a stock on which to top-work the permanent kinds after the trees are thoroughly established in the orchard. The Northern Spy has been the principal stock for winter varieties in northern apple sections, and the Astrachan and Tallman Sweet have been freely used for the fall and summer kinds. The Ben Davis and the Baldwin have been planted to a limited extent, but their merits are not yet well determined. These trees are clean, straight, vigorous growers, comparatively free from body diseases, and they grow into uniform, pleasing trunks for the permanent orchard.

The practice of top-working has some important advantages in commercial orcharding. First, it provides a uniformly strong, healthy trunk for all varieties, making many of them longer lived, corrects the crooked, gnarly habit of some, overcomes the tenderness of desirable kinds that cannot flourish on their own bodies in the far north, and sometimes, as when the Spy is used, is said to make a stronger system of roots. Second, it gives the grower a chance to select the buds or scions from trees of steady productiveness, with hardy foliage, with large, highly colored fruit, and with other superior qualities. Third, it is said to hasten the fruitfulness of young orchards.

## SELECTING THE STOCK.

The best stock on which to top-work the young orchard is a vigorous variety, as rapid in growth or more so than the top, upright in habit, and as free as possible from body diseases. The canker, the sun-scald, or any other body trouble may cut off the orchard just at the beginning of its profitable existence if a susceptible stock is planted. The King, the Twenty Ounce, the Spitzenberg, the English Russet, and the Early Harvest are included in this undesirable list, and others may be added in every apple-

growing section. The Spy is an ideal stock for the middle Atlantic states. It is strong, healthy, clean-cut, and forms an unusually deep system of roots. The Ben Davis is good, the Lilly of Kent very promising, and the Tallman Sweet desirable for summer kinds. Although we have no direct evidence on which to base the statement, we feel, on account of the interrelationship of stock and scion, that winter stocks should be used for winter apples and summer and fall stocks for varieties ripening in those seasons.

It is frequently asked why seedling stocks should not be used on account of their cheapness. If the cost of the trees is the only point to be considered in deciding on the stock, the seedlings would be chosen in preference to an expensive variety. But the cost of the stock should be the least of the factors that enter into a long-time orchard investment. Permanency is the first essential. No two seedlings are alike. They differ in vigor, in hardiness, in healthfulness, and in form just as named varieties do, and by using them one of the chief reasons for top-working—the provision of a uniformly vigorous, healthy body—is defeated.

### SELECTING THE BUDS.

The buds for the permanent varieties can be selected from trees of superior merit and used in the new orchard. Propagating buds are generally selected indiscriminately from bearing trees, from young trees, or from nursery stock. The trees of an orchard, however, differ among themselves. Heavy bearers, shy bearers, steady bearers, and erratic bearers may be found in every orchard of the same variety. They differ also in their fruit, some producing large, highly-colored apples, others small, dull specimens. The foliage varies, too. I have seen a Spitzenberg carrying rich, green leaves throughout the season when the surrounding Spitzenbergs were brown with the apple-scab. And if the line of thought is carried further the grower may observe differences of a similar kind in the branches of a single tree. The tree is made up of a society of individuals with the bud as the unit of the group, and it is a primary axiom that no individual in nature is just like any other one. Sometimes there is such a striking variation in a branch that it is profitable to propagate it as a new variety. Such was the origin of the Cannon Early or Delaware peach of Delaware, the Banks apple of Canada, and the Pierce grape of California, which originated on branches of the Montana Rose, the Gravenstein, and the Isabella.

The indiscriminate cutting of buds for propagation is a prenicious practice that should be replaced by a more rational choice of bud selection. A vigorous-growing, upright tree has been the ideal for fruitgrowers and nurserymen alike. Neither has concerned himself with the individuality of the trees from which the buds are taken. In fact, much of the nursery stock is propagated generation after generation from buds from the nursery row, for the commercial reason that nursery buds make larger trees and more of them than buds from bearing trees.

The individuality of a tree cannot be determined by the observation of a single season. But when it has been shown, after several seasons of severe comparison, that a heavy or regular-bearing tree is stable in its habit, then

there is little question about the transmission of its characters through its buds.

Top-working is thought to hasten the fruitfulness of young orchards. Definite experiments are progressing, which are expected to throw light on the question. It is reasonably certain, however, now, that young trees top-worked with buds from mature trees will come into fruitfulness sooner than those propagated in the usual manner.

### TOP-WORKING METHODS.

Well-grown, medium-sized two-year-old trees, with well-developed roots and tops, should be set in the orchard for the permanent stock; and the second summer afterwards they may be budded, or they may be grafted at the beginning of the third season. To illustrate, if an orchard is planted in 1901 it may be budded in the summer of 1902 or grafted in the spring of 1903. It may be budded during the season the orchard is planted, but we think that at that time the trees are not well enough established.

### GRAFTING.

The top-working may be done either by budding or by grafting; frequently both methods may be advantageously combined on the same tree. Grafting is the process of inserting a scion into a stock so that the growing parts of the two are in contact. The operation is done in the spring, just as the leaves are pushing forth. It may be done for a month longer, though the scions will not grow so large. The scions are inserted on three to five branches in top-working, or sometimes they are inserted in the central leader alone. Care should be exercised in selecting the branches, that they are well distributed on the trunk, no two being closer than four or five incnes apart. On all branches less than a half-inch in diameter the whip or tongne-graft is used; on larger limbs the cleft-graft is employed. As soon as the scions begin to grow in the spring all of the remaining branches of the stock should be cut off. A branch-grafted tree develops into a well-formed specimen, if the branches have been properly balanced and all of the scions live. If some of the scions do not start an ill-shaped top develops and a year elapses before the form can be corrected, unless June buds are inserted on the branches in which the buds have died. In those sections of the country where bud moths are destructive, branch-grafting has serious objections and should be replaced by body-budding.

The body-graft also develops into a shapely top if the scions live, but if they happen to perish, nothing but the stock remains. The branches which are put forth by the stock can be budded in June or in August, or grafted the following spring. It is not often that a balanced tree can be formed after the body scion has died. The cleft-graft is also used on the body, but it is undesirable. An enlargement often occurs at the union, and the cleft sometimes heals with difficulty, or a scion may be blown out, leaving an ugly wound which may eventually lead to the decay of the trunk.

### BUDDING.

The young orchard may be budded. Budding is the insertion of a bud, with some bark attached, under the bark of the stock so that the growing cells of the bud and the stock are in contact. Budding may be done whenever the bark will peel, which happens in early spring and later on from June till September, or even later. Budding is usually done in August, but in this latitude the buds on the new wood are sufficiently mature for use by the middle of June. August buds usually remain dormant until the following spring, but June buds make a foot and a half of growth the same season if the orchard is well cultivated.

The buds may be inserted on the branches, on the body, or in both of these positions on the same tree. In budding the branches, three to five small limbs are selected, which, taken alone, form a well-balanced top. No two branches should be opposite, and it is advisable to have them five or six inches apart. The buds should be inserted so that they will eventually develop into a shapely top. It is generally advisable to insert the buds several inches from the trunk, so that the same branch can be rebudded or grafted if the bud dies. If the orchard is an exposed location, the August budded branches should be headed back in the fall to prevent the winter winds from breaking them at the point where the bud is inserted. In the spring the budded branches are cut off about an inch beyond the buds, and the unbudded branches are all removed as soon as the buds start into growth. A month later, when the buds have grown a foot, and the danger of breaking out is lessened, the stub beyond the bud should be cut back close to the point where the bud is inserted, so that it may heal over during the season. In June budding, the budded branches are treated in the same way as soon as the buds have set.

The branch-budded tree develops into a beautifully-formed specimen when all of the buds grow: but, like the branch-grafted tree, the top is ill-shaped if the buds do not start. If June budding is practiced the missing places can be filled with August buds, while the top can be balanced by whip-grafting the following spring whenever an August bud fails to grow.

The most satisfactory form of top-working is body-budding with three to five buds. The buds are inserted spirally around the tree five or six inches apart, though the branches of the stock sometimes interfere with an ideal arrangement. The emphatic advantage of this method lies in the ability of any one of the buds to form the top if the others perish, for the surviving bud grows out as a leader and eventually straightens into a perfect top.

Budding is usually more satisfactory than grafting. It is easier to perform, more quickly done, the wound is not so severe, and the several portions heal more rapidly, with less danger of infecting the body of the tree with organisms that may eventually lead to its decay. But the top-worker will find that the best results follow the adoption of both methods on the same tree whenever one is needed to supplement the other.

### CARE OF THE TOP-WORKED TREE.

The most important period in shaping the future of the top-worked tree is the first season that the scions grow. Except in June budding the orchard should be gone over three or four times and all water-shoots removed, or they will smother and dwarf the scions. It is not advisable to remove all the branches and shoots from June-budded trees, for the scions may grow so rampantly that they are easily blown out by the fall winds. The unbudded branches, however, may be removed, but the shoots growing from the budded branches and from the body should be left and cut out the following spring.

It may be necessary to head in many of the scions about the middle of July or the first of August, for they often grow so large that there is danger of their being broken out. The scions will throw out many side branches, and some of these may need heading in and others may need removing. Nearly all of the pruning the first year can be done with the finger and thumb. It cannot be emphasized too strongly that it is during the first season that the greatest care is needed in properly shaping and protecting the new top. If this attention is neglected top-working as an orchard practice is bound to lead to disappointment; if wisely bestowed its value will continue to grow with the experience of the operator. It cannot be left in the hands of the careless employee. Intelligent, unremitting, personal care is the price of a satisfactory outcome, and if this cannot be given the permanent varieties had better be bought in the old-fashioned way.

# THE WALNUT.

By B. M. Lelong, Secretary California State Board of Horticulture, and Chief Horticultural Officer.

### COMMERCIAL IMPORTANCE.

Holding a prominent place among the fruit products of California, stands the walnut. This position has been attained in the past few years, and is the result of experience—and many failures—which have shown the proper conditions under which this fruit will thrive, its requirements in soil, climate, and location, and the production of varieties adapted to the peculiarities of our state. The oldtime saying that the area of walnut culture in the state is "very limited" and confined to any particular section, has, by happy chance, proved a fallacy, and is disproved by the numerous productive orchards that bear witness to its successful culture. While the early plantings were made in the southern counties, where the culture of the walnut is pursued with great magnitude, the industry is gradually spreading and broadening. While the walnut will withstand a very low temperature, it is

An Eight-Year-Old Walnut Tree.
From the seed; being the age seedling walnut trees begin to bear.

very susceptible to sudden changes, and a hot day suddenly following a frosty night will chill the young wood, and often proves fatal to a young orchard, setting it back a season's growth. The same is true in the springtime on the opening of the flowers or catkins—a chill will frequently cause them all to drop and render the crop a failure. For this reason a location free from prevailing frosts, or one where the sun will not strike the trees until the effects of the cold have been overcome, is very desirable. The latter trouble can be largely overcome by planting some of the late-blooming varieties, which do not send forth their catkins until danger from frosts is largely past.

California walnuts are fast supplanting those from foreign countries. Only a few years ago the growers of these nuts here had a very hard struggle to introduce them, being obliged to accept the humiliating price of from three to six cents a pound less than than that paid for imported walnuts. Gradually, however, a reduction came, in favor of the California product, and now eastern dealers will take our best walnuts at prices equal to, and in many cases exceeding, those obtained for those coming from abroad. Our state affords a splendid field for the walnut industry, and although thousands of trees have been planted, and the acreage is being extended every year, it is believed that overproduction need not be feared. Our producers have all America for a market, and they are not slow to appreciate the advantages of their position.

## THE "ENGLISH" OR "PERSIAN" WALNUT.

The walnut (*Juglans* regia*, Linn.) is a native of Persia, and is supposed to have been introduced into our state by the Franciscan monks during the establishment of the California missions in 1769. Records of its early history are scant, but mention is made of walnut trees growing about the missions by most of the writers of the "Record of the Founding of Missions," and the "History of Franciscan Missions of California," and, therefore, it is safe to assume that with the advent of the missions dates the introduction of this valuable tree. In the mission yards are yet to be seen walnut trees of those early plantings, and while age began to tell on these many years ago, they still live and bear nuts, but few in number and small in size.

The largest walnut orchard of early planting in the northern part of the state is located near Los Gatos, in Santa Clara County; it is about thirty years old, and produces fair crops yearly. The largest orchards of recent planting are in Lake and Sonoma counties. In San Lorenzo, on the William Meek estate, is an extensive walnut orchard of early planting. In Sonoma, at the Vellejo place, and at Mission San Jose, are many walnut trees that show great age and are healthy in appearance. General Bidwell, at Chico, has a considerable number of walnut trees, all vigorous and fruitful. Many such trees are to be found in Napa, San Jose, Santa Clara, Merced, Modesto, Fresno, and Visalia. Along the coast, in almost every county, are to be seen large walnut trees of early planting. While these early plantings were

**Juglans* is a genus of trees consisting of six species; three are natives of the United States, viz.: *J, nigra*, or black walnut; *J. cinera*, or butternut, and *J. fraxinifolia*, or ash-leaf walnut. The other three species are *J. regia*, "English" or "Persian" walnut; *J. pterocarpa* grows on Mount Caucasus, and *J. baccenta* in Jamaica and Spain.

small, and many consisted of isolated trees, as were those in the mission gardens, yet those trees mark a special epoch in the horticultural history of our state, as they have proved the great longevity of the walnut, and enlightened the growers as to their culture and future possibilities.

### LONGEVITY OF THE WALNUT.

The great and prodigous age attained by the walnut can only be conceived from records of its early history. All the early botanical writers—English, French, Italian—point out the fact that the walnut, in their respective provinces, does not bear until it has reached the age of fifteen to twenty-four years, and hardly becomes a paying investment until it attains a prodigious age. In California, the walnut begins to bear at the eighth year from the seed, and from that time on the crop increases, and the orchards become remunerative. It is now not uncommon to see walnut orchards from thirty to forty years old, in the prime of health, producing every year bountiful crops.

* "In Persia, the tree comes into bearing at eight years from the planting of the seed; in Italy, Spain, and the Island of Maderia, in about sixteen years; in France—the southern part—in eighteen years; in England, in twenty-four years, and in California, in eight years, the same as in Persia. So, I take it, the southern part of this state is nearest its home."

† "After fifteen or twenty years from the time of planting, the walnut gives only hopes, so to speak, for its yield is yet so small that its value can hardly be reckoned; it is only from thirty to sixty years that this tree can offer each year a product sufficient to increase the income of the landlord. It takes a century, and over, before the wood is good to be used in the arts."

‡ "Walnut trees are spoken of that bear, in good years, fifty thousand to one hundred thousand nuts; such trees are truly very rare, and their trunks are not less than fifteen to twenty feet in circumference."

### POLLINATION.

Until recent years no attempt was made to improve the varieties of the walnut in cultivation by cross-pollination, but the universal practice has been to plant the nuts selected from fruitful and rapidly-growing trees, and the seedlings grown therefrom, on not becoming regular bearers, were dug up, as were also all trees producing inferior nuts. Trees producing nuts deficient in kernels were not uncommon, but were frequently reported, and many such trees still exist. From past experience it is readily to be seen how important it is for the grower to study and know the varieties, so as to plant and locate them in the orchard so that they may assist in the pollination of one another. In fact, the study of pollination becomes essential as the first step to successful fruit culture.

* Hon. Russell Heath, in essay before Eleventh State Fruitgrowers' Convention, 1889.
† Maison Rustique, Vol. 2, Chapter XII.
‡ Maison Rustique, Vol. 2, p. 143.

WALNUT BRANCH.
Showing development of male flowers, or staminate catkins, with the first period of growth two weeks before the appearance of the female flowers or pistillates.

WALNUT BRANCH.—Showing both staminate or male catkins and pistillates or female flowers in full bloom, having appeared together, or nearly so. The male organs or catkins emanate from the bud-cells in the axils of the leaves on twigs of the preceding summer, and the female flowers at the terminals of the new growth, with the embroyo nuts.

WALNUT BRANCH.

Showing male flowers or staminate catkins after blooming, and the female flowers or pistillates (and embryo nuts) above, just in bloom, having made their appearance two weeks later, and ready for fertilization.

In many instances it has been observed that some trees will produce at times an abundance of flowers of one sex, and few or none of the other sex. Trees—as the walnut—that mature their pollen before the female flowers on the same tree are ready for fertilization, are called by botanists *proterandrous*: while others, called *proterogynous*, have their stigmas mature before the pollen is ready. The purpose of this curious functional difference obviously is in favor of cross-fertilization, by pollen, of flowers borne by other trees of the same species.

According to the *Gardeners' Chronicle*, in 1888, reports became current of trees in portions of the walnut sections of France bearing a full crop, but the nuts failed to harden, the husks, when about half grown, withering up, and few good nuts were found. The kernels which were formed, were soft and insipid. Reports made throughout were that "while there were plenty of nuts, there was nothing in them," and after assigning different reasons for this failure, conclude "probably from imperfect fertilization of the flowers." Many other similar instances are reported as occurring in different groves.

*"It is a common occurrence for the walnut to be deficient in producing either the male or female blossoms, which it bears, both of which are essential to its producing and ripening nuts. I have a tree, now about twenty years old, which began a few years ago to show blossoms, but those merely female, without one male catkin appearing on the tree, and the consequence has been that after the flowers faded, the fruit regularly dropped off. This season, there being a considerable show of female blossoms but no male ones, I thought of trying the plan followed by gardeners in the case of mellons and other fruits where fertilization is not freely effected by nature, and having seen abundance of male catkins on a tree at a friend's, I asked him to send me some, and he accordingly sent me a small paper-bag full, which I dusted and threw over such of the female blossoms as were within my reach. The consequence has been that I now have about a dozen fine nuts, swelling out regularly, with every appearance of coming in due time into maturity. All the embryo fruit not fertilized have fallen off as usual. I am pleased with the result of my experiment, and mean, should my tree still prove deficient in male blossoms, with the assistance of my friend's, to supply its wants, and, by taking a little more trouble, I have no doubt I shall be able to render every female blossom fruitful."

As showing this curious functional difference in our own state, a few facts are cited. A nurseryman at Ventura observed a large seedling walnut tree, which, from its luxuriant growth and symmetrical form, he believed would be a variety worthy of cultivation. Accordingly, in the spring of 1886, he planted forty pounds of nuts gathered from that tree. When the seedlings bore, none of them produced nuts of any commercial value. This, of course, proved to be a sad disappointment to him, and, after waiting ten years for a crop, he dug up most of them. Some of the trees had become of large dimensions and had long, spreading branches, and were always quite full of nuts, but without kernels — all hull and shell. This functional difference was investigated; the trees were found to produce an abundance of flowers of the same sex, but few or none of the other, through which imperfect fertilization of the flowers, the kernels in the nuts did not form—they were wanting. It

*Gardeners' Chronicle London, 1847, p. 541.

is also interesting to note that no attempt was made to correct this curious phenomenon by artificial cross-pollination, by distributing pollen from staminate catkins, or male flowers, of other trees, before digging up the trees.

Through the continuous planting of the seed (as mentioned elsewhere), without regard to the laws of nature, has come about the degeneration of the species in many sections. Trees are frequently reported as having "never borne nuts;" others "bloom profusely, but are blooms of only one sex; the nuts have never set, and have become a barren waste." This is a summary of the reports that have been continuously received for years past. In recent years more attention has been paid to the morphology of the walnut, and it is now better understood.

*I have a few trees of the ordinary English walnut. In 1878 the staminate blossoms came out in the latter part of March; they dropped off and perished on the ground. About the fifteenth of April the pistillates made their appearance. The result was the nuts dropped off. The next year the staminates made their appearance the first of April; they dropped off by the tenth, and between the twelfth and the fifteenth the pistillates made their first appearance. The result was I had no walnuts. The next year, 1880, I found the blossoming periods came closer together, within a few days. About the first of April the staminate blossoms dropped off, and in a few days the pistillates began to make their appearance. I looked over the trees and found a few stunted staminate blossoms. I gathered them very carefully, and shook them over the trees. The result was that every tree over which I distributed the pollen was laden with walnuts.

Incidentally, I may mention that almond growers were in a worse predicament, and in many sections the culture of the almond was abandoned. The Languedoc, a variety first introduced, was found to produce an extraordinary large number of flowers of one sex, and few of the other. The morphology of the almond was studied, with wonderful results, and many of the same localities are again planted to the almond, and are among the leading almond-growing sections of the state. It was also found that by planting different varieties in an orchard alternately, the pollen would intermix and aid in the setting of the fruit. This, however, was done in many cases without studying their blooming period, and consequently failure resulted. For instance, seedling trees of bitter almond were planted in the orchard, as they were profuse bloomers, but the time of blooming was not considered. Seedling trees of the bitter almond are among the first to bloom, and put forth two weeks or more ahead of the standard varieties, so that when the latter came into bloom the pollen of the bitter almond had either been washed off by early rains, or lost through other unfavorable conditions, preventing its action on the other flowers. In order to accomplish the results aimed at, the varieties so intermixed must bloom together, or nearly so. I know of no instance where this has been tried on the walnut, but it is certainly worthy of a trial, as it may tend to correct this curious phenomenon, prevalent among some of our walnut orchards complained of, consisting of trees grown from seed. Of course, with the almond the experi-

*W. H. Jessup, of Haywards, in essay read before State Horticultural Society, April 27, 1883.

ment was much easier, because, after testing a certain variety, and its merits becoming fully known, they were reproduced by budding. The long period required by the walnut to come into bearing was a bar to any experiments in this line, and it was grown from the seed almost altogether. But this is no longer so. Fruit culture has reached the height of perfection, and is now being conducted on broad lines and scientific principles. Inferior seedlings are giving way to grafted and budded trees of the choicest kinds, or to seedlings of chosen selections; their habits are studied, and the novice or the grower does not have to wait and undergo years of toil and anxiety to acquire results, but can profit by the experience of others who have made fruit culture the study of their lives, and who show their liberality and warmheartedness by sharing this knowledge with their neighbors.

### ORIGIN OF IMPROVED HOME VARIETIES.

While large walnut orchards were set out, and many new plantings made every season, consisting mainly of seedling trees produced from seed from the old historic trees of early introduction, no attempt was ever made to produce improved varieties by cross-pollination, and none are yet recorded. Only recently have improved varieties become known, and these originated from chance seedlings. In 1867 Mr. Joseph Sexton, of Goleta, Santa Barbara County, purchased in San Francisco a sack of walnuts supposed to have come from South America, labeled "English Walnuts," from which he raised about one thousand trees, and the spring following (1868) planted two hundred of these trees in orchard form at Goleta. Sixty proved to be of a soft-shell variety. Later he planted twenty-four trees raised from soft-shell nuts from his original trees; of this number twenty-one came true (the same) to the parent tree, and three made a much stronger growth, commenced fruiting in the sixth year, and pioduced a soft-shell nut, and an improvement over the original trees. The first he named Santa Barbara Soft-Shell, and the latter Improved Soft-Shell, by which names they are now known. In 1859 Hon. Russell Heath, of Carpinteria, furnished Mr. Stowe, at Santa Barbara, with a large quantity of walnuts from his orchard of so-called "English" walnuts, for planting. Among the trees that Mr. Stowe raised from that seed, one produced soft-shell nuts. It is Mr. Heath's firm belief that this nut must have come from a chance seedling produced by him from seed which he procured from the orchard of the late William Wolfskill, at Los Angeles, from whom he obtained his first seed. There is no instance on record where any soft-shell walnuts had been produced prior to that time.

Mr. George W. Ford, of Santa Ana, originated soft-shell walnuts, which he christened Ford's Eureka and Ford's Improved Soft-Shell. They were produced from seed grown by Mr. Sexton, of Goleta. Mr. Felix Gillet has originated the California Paper-Shell, the Columbus, the Cluster Prœparturiens, and the Mayette-Shaped Prœparturiens. Many other varieties have been catalogued, mostly because they were new, but were never passed upon by any competent authority, or their merits determined. Most of these trees, on coming into bearing, produced a nut similar to that of the tree

WALNUT BRANCH.
Showing the mature nuts through the cracking of the husks, ready for harvesting.

FIG. 1.—Branch of walnut showing character of growth, and an extraordinarily large amount of male, or staminate, catkins; reduced.

FIG. 2.—"Root knot" on young walnut.

from which they originated as chance seedlings. These various types, not being distinctive enough to be classified by themselves, are all labeled "English Walnuts."

VARIETIES OF THE WALNUT—ENGLISH.*

(*Juglans regia*, Linn.)

(Plate X, Fig. 2.)

Synonyms: Maderia, Naples, Los Angeles, Common, Chile, Mission, etc.

This walnut was the first introduced into our state; from it innumerable varieties have sprung, and of which the principle orchards of the state consist. The name is applied to any variety of the so-called English walnut. It would be difficult to determine the particular variety to which this name belongs; however, it is a name applied by common consent to any and all varieties that have originated from the so-called English walnut, and really is more of a commercial name through which the product is marketed.

The principal orchards of the state consist of trees grown from seed of the so-called English walnut, and while the walnut comes truer to seed than most fruits, it could not be claimed that all the orchards of the state are of this particular variety, simply because the trees were raised from seed of the original stock. In almost every orchard of the state of early planting are trees bearing nuts wholly unlike the nuts produced by the parent trees, and they can only be classified as types of the original nut, showing the great variation produced from planting the seed. Many of these orchards, however, consist of types of rare quality, such as the orchards in the Los Nietos Valley, Santa Ana Valley, San Gabriel Valley, Carpinteria, Santa Barbara, etc. While most of the types that originated from the seed grown on trees of early planting produced a hard-shell nut, there were many that produced a thin or soft-shell nut. The best and most productive orchards today consist of trees grown from seed of the original trees.

To describe the so-called English variety would be as difficult as to describe the seedling orange and its many types. Oranges cultivated from seed are known as seedlings, but as the seed from these seedlings has been planted continuously, and though the trees so produced bear fruit so distinct and so variable, they are only seedlings from seedlings, and are accepted under that name without regard to variety.

Among those trees of early history were many that produced large, clear, hard-shell nuts, which were greatly sought in the market. The nuts of this type were in great demand for planting, although by continuous propagation from the seed for nearly half a century, without regard to the degeneration of the species, many of these types have been allowed to degenerate until their cultivation has been almost abandoned.

While seedling trees and small orchards of this so-called English walnut, or Los Angeles nut, are met with in almost every county of the state, the

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*For want of a better name, and to indicate the locality from whence it came (as it is supposed by all the earliest British botanical writers to have first been introduced into England by the Romans), it was called commercially the "English walnut."

successful culture of this nut and its many varieties has been confined to the lower counties—from Santa Barbara to San Diego. Trees grown from seed of this nut—English—in many sections have proved too tender to withstand the cold of winter and the heat of summer. They generally get cut back by frost* in the spring, as they put forth too early to escape them. The trees keep growing quite late in tne season, and the tender shoots and undeveloped growth suffer from extreme heat, and are nipped by the frost in the fall.

Of late years several late-blooming varieties produced by chance have come into prominence, having most of the essential qualities required, and which are proving successful everywhere, and will hereafter, no doubt, supplant all others of this species.

While the walnut has reproduced itself, that is, "come the same," from seed, it has a tendency to revert to the wild state, as is the case with all trees when continuously propagated from seed. A variety can only be reproduced and remain constant by budding and grafting. In this state many such instances have been cited and recorded.

## EUROPEAN VARIETIES.

The varieties described in this chapter have proved most promising of the numerous kinds introduced into our state of recent years. The descriptions given are by leading growers, whose opinions are worthy of fullest consideration:

*Persian*—Generic commercial name, applied by common consent to all varieties of the *Juglans regia*.

†*Chaberte*—(Plate XI, Fig. 9.)—An old and most valuable variety; late in budding out. The nut is well shaped, roundish-oval, and of fair size; the kernel is of extra fine quality; good bearer. The Chaberte originated in France over a century ago, by a man named Chaberte, hence its name.

"The Chaberte is a good and thrifty variety."—West.

"The tree is very productive, developing its leaves and blooms late in the spring."—Rock.

†*Franquette*—(Plate X, Fig. 5.)—Blooms late in spring. Originated about the same time as the Mayette, in the southeast of France, by a man named Franquet. It is quite large, of an elongated oval, and very attractive; the kernel is full-fleshed and sweet, and of rich, nutty flavor. It also buds out late in the spring, being as hardy as Parisienne and Mayette. Very desirable as a market nut.

"Nuts very large and long; one of the finest for dessert."—Rock.

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*On March 2, 1896, the northern and central portions of the state were visited by a severe frost and snowstorm. On the morning of the third I examined the growth of the English walnut in several orchards, which had already grown about four to six inches, and found much damage done to both the growth and the male catkins. The European varieties did not show any signs of starting. On March 15 the pistillates of the English walnut made their first appearance, but all the male flowers, or staminate catkins, had dropped off. On March 22 the European varieties began to put forth. As a consequence there was no crop of English walnuts, but the European varieties set well.

†Described by Mr. Felix Gillet.

**Mayette* (Plate X, Fig. 3).—This is one of the finest dessert and market nuts grown. It is quite large, and uniformly so; well shaped, with a light-colored shell; the kernel is full-fleshed, sweet, and nutty. But what renders this valuable kind more valuable yet is that it is very hardy, being late in budding out, which enables it to escape uninjured the disastrous effects of late frosts in the spring; it is also an abundant bearer. This is the nut imported into the United States under the name of Grenoble, but on accoun of the duties to pay, and the nut being high-priced in its home in France, a common and cheaper grade is often mixed with it, to the disgust of nut importers in New York and Chicago. The Mayette was originated by a man of the name of Mayet, one hundred and thirty years ago, having ever since been a great favorite as a market nut.

"My trees did not produce until the sixth year. They are a large, excellent nut."—West.

"One of the finest dessert nuts grown; large full-fleshed, and sweet. Very late in budding, thereby escaping injury from late frosts."—Rock.

**Mesange*—This nut has a very thin shell, and derives its name of Mesange from a little lark of that name that goes to the kernel through the tender and thin shell; very productive. This may be regarded as a first-class family nut, but I would not recommend it as a market nut, on account of its rather small size and thinness of shell.

**Vourey*—This new and valuable variety of recent introduction originated near Vourey, France, hence its name. The nut has the shape of the Mayette, but is more round and smaller; the shell is thin, light-colored, and smooth, and the kernel exceedingly sweet and nutty; very hardy.

"The nuts are very large and the shell well filled with a sweet, rich kernel. The leaves and flowers are produced late."—Rock.

Grenoble (Plate XI, Fig. 5).

**Meylan*—A new and very attractive variety, originated near the little village of Meylan, in the walnut district of France. The nut is of fair size; the smoothest one of our collection, vey thin shell, and of excellent quality; buds out late.

**Serotina* (*St. John*) (Plate XI, Fig. 3)—I find this variety not to be so late in budding out as to not be sometimes injured by late frosts in the spring. The nut is of medium size, well-shaped, with a very sweet, nutty meat; enormously productive.

"This variety came into bearing the fifth year from planting. It is of less value than others grown by me. Its flavor is not quite so delicate, and the shell a trifle harder, but as it is a week later in showing leaf in the spring, it will suit frosty localities."—West.

"Leaves and flowers of this variety are not developed until all danger of frost has passed; very productive."—Rock.

Mobart (Plate XI, Fig. 2).

**Vilmorin, or Cross-Bred*—This curious variety was obtained by "hybridizing" years ago, in France. It is a cross between the English walnut and the eastern Black walnut, and was called Vilmorin after the leading member of the well-known seed firm of Vilmorin, Andrieux & Company, of

*Described by Mr. Felix Gillet.

Paris. The nut is small, and has the shape of the English walnut, but the furrows of the Black walnut: it is darker than the English and lighter than the Black. It can hardly be called an improvement on the Black walnut; surely it is not on the English. It is a very odd sort, having no commercial value whatever. We have fruited this cross-bred walnut for the last seven years, and find that either as a family or market nut this cross-bred variety is entirely worthless. It must be regarded and propagated, therefore, simply as an ornamental variety.

**Weeping Walnut*—A new and very curious kind of walnut, highly ornamental, the branches drooping down like those of the weeping-willow. We have had limbs on some of our weeping walnuts growing to eight feet through the summer, drooping straight down, with the ends dragging on the ground, and even trailing on it to a length of twelve to twenty inches. The nut is of fair size, oblong, thin-shelled, and of good quality. It looks to be a very abundant bearer.

Rivera Hard-Shell (Plate XI, Fig. 7). Rivera Soft-Shell (Plate X, Fig. 8).

**Laciniated, or Ash-Leaved*—The foliage of this kind of walnut is so delicate, so finely cut up, that it makes of it a most graceful ornamental tree, worthy to be planted conspicuously in the garden or front yard. The nut, besides, is exceedingly pretty, of fair size, round, with a very smooth shell and sweet kernel. The tree is claimed to be an abundant bearer.

**Parisienne*—Large, excellent, starts late in spring. This beautiful nut, also one of the finest for dessert and market, was originated in the southeast of France, and not in the neighborhood of Paris, as its name would imply: its beauty made it called Parisienne, in honor of the capital of France. The nut is large, broader at the small end than the Mayette and Franquette, and has a very pretty shape. It is as late as the Mayette, and as desirable for market.

"A most beautiful nut; one of the largest and best for dessert, broad and large, with full-fleshed kernel. Bears early and regular."—*Rock.*

**Alpine, or Wonder of the Alps*—A new and very rare variety; originated not long ago in the Alps Mountains, in France. Next to the Mammoth, it is the largest walnut grown on my place. Though the shell looks a kind of rough, it is perfectly soft and thin, and the meat sweet and filling well the shell.

**Lanfray*—A newly originated variety. Very pretty nut, oval in shape, of fair size and first quality.

**Poorman*—A new kind, of recent introduction.

Fertile (Plate XI, Fig. 1).

**Prœparturiens, or Fertile, First Generation*—This variety was introduced into the state by me, in the winter of 1870-71, and in my grounds, two thousand six hundred feet up in the Sierra, are the first trees of that kind that ever produced fruit in this state. Described as follows: The Prœparturiens was originated in France, in 1828; from the fact that it first bore nuts while being but two years old, the Latin name of Prœparturiens was given to it from *Parturiens*, bearing, *Præ*, before—bearing before the usual time. It

*Described by Mr. Felix Gillet.

was also called Fertile, on account of its surprising fertility. The nut is small, though thin-shelled, and very sweet: it is this nut that produces "Second Generation" trees.

**Præparturiens, or Fertile, Second Generation*.—The Second Generation Præparturiens, the kind we recommend to plant, has retained all the characteristics of the original, only the nuts are much larger, and larger, too, than those of the third and fourth generations, seventy-five per cent. of the trees bearing nuts from medium to large, and twenty-five per cent. from small to medium, and of all sorts of shapes—all, however, being thin-shelled and of first quality. The Præparturiens is one of the most productive kinds, and bears heavy crops from the start, and it may be regarded as the best variety of walnut to plant for family use: the largest Præparturiens nuts, though, being well marketable.

**Third Generation Præparturiens*.—The kind mostly sold in California under the generic name of Præparturiens, and grown from nuts borne on second generation trees. The nut is generally small—too small for market, but of first quality.

**Mammoth Præparturiens*.—A large-fruited variety of Præparturiens, originated in France. The nut is extraordinarily large: soft shell, and with a full-fleshed kernel.

*Præparturiens*—(Plate XI, Fig. 8)—"This variety has proved exceedingly satisfactory. It will bear in nursery rows when not more than four feet high, and continue to have a crop every year, and has never been injured by spring frosts. On my place are seedlings of the second and third generations, which still convey their fertile and early-bearing qualities. The nuts on mature trees are of good size and of the best quality."—West.

*Gant* (Syn. *Bijou*) (Plate XI, Fig. 4)—"Nuts very large, twice or three times larger than the common walnut, and sometimes square or oblong in shape."—Rock.

"The Bijou is the largest walnut known. This variety began to bear when it had been planted four years, and has constantly increased its yield. In 1890 it bore a large crop, and in 1891 it set its fruit so quickly that I thought best to remove at least one-third of it. The reputation of this tree in its home—France—is that of a shy bearer. The quality is excellent, superior to aything I have seen."—West.

**Mammoth, or Jauge*.—This is an immense nut, the largest yet originated. So large is the shell of some of them that "ladies' companions" are made out of the shells by fancy-goods manufacturers, wherein to stow away gloves and handkerchiefs. The nut, though of such large dimensions, has a thin shell, and the kernel is of first quality.

**Cluster* (*Juglans racemosa*) (Plate X, Fig. 7)—This remarkable kind of walnut, introduced some twenty years ago into this country, is a worthy rival of the Præparturiens for productiveness, but superior for the beauty of the nuts. It derives its name of *Juglans racemosa* from the Latin word *racemosus*, meaning abundant in clusters, full of clusters, which is the main characteristic of that most beautiful variety. The nuts, when the tree is in full bear-

*Described by Mr. Felix Gillet.

ing, grow in long clusters of ten, fifteen, and even twenty-five to twenty-eight nuts. The Cluster, like the Prœparturiens, reproduces itself well enough from the seed, provided that the nuts are gathered from trees grafted from the original. The nut is thin-shelled, of fair size, hermetically closed, with a smooth, white shell; in fact, a perfect beauty.

**Barthere*—"A singularly shaped nut, elongated, broad at the center, and tapering at both ends; the shell is harder than that of other sorts."

*Kaghazi*—Of doubtful origin; grown about Niles, in Alameda County.

*Grand Noblesse*—Discribed in "Nut Culture in the United States," as having originated by L. L. Bequette, of Los Nietos, but is very little known by the growers of that section.

### VARIETIES OF HOME ORIGIN.

The chapter on pollination of the walnut illustrates how varieties originate by accident, or from chance seedlings. The following varieties originated in that way; they have been fully tried and their merits have become known, and are therefore entitled to be placed among the list of varieties worthy of cultivation:

**California Paper-Shell* (Plate X, Fig. 1)—Originated by Mr. Felix Gillet. A nut borne on a grafted Chaberte, the tree being, therefore, a second generation Chaberte. The nut is only of medium size; shell very thin and almost white; kernel full-fleshed, exceedingly sweet and nutty.

**Columbus*—Originated by Mr. Gillet. Produced from a second generation Mayette. The nut is very large, exceedingly pretty, roundish, with smooth, light-colored shell, and kernel of first quality. Named Columbus in honor of the World's Fair in 1893, the year that my second trees of that kind went into bearing.

**Mayette-Shaped Prœparturiens*—Originated by Mr. Gillet, some twenty-five years ago. A large nut, sitting on its end like the Mayette, hence its name. Full-fleshed kernel of first quality; heavy bearer. Solely propagated by grafting.

**Cluster Prœparturiens*—A variety of Prœparturiens said to be very fine, also originated by Mr. Gillet. Nut large, oblong, smooth surface, perfect soft-shell; kernel fine and sweet. Growing in clusters.

*Soft-Shell*—Originated from seed, by Mr. Joseph Sexton, of Goleta, Santa Barbara County, in 1868. The seed he procured in San Francisco, which was labeled English, and was supposed to have been imported from Central America. Mr. Sexton describes this variety thus: "Nut looks very much like the imported Chile walnut, having the shape and color. The objection to this variety is that as the trees grow older the nuts grow smaller—diminish in size—and are not as salable as larger nuts."

*Improved Soft-Shell* (*Santa Barbara Soft-Shell*) (Plate X, Fig. 10)—Originated by Mr. Joseph Sexton, of Goleta, Santa Barbara County, in 1870, seed of the Soft-shell, crossed with the hard-shell or English walnut. The nut

*Described by Mr. Felix Gillet.

in outer appearance resembles the English or hard-shell, but shell is as thin as the Soft-shell, and the kernel or meat is a beautiful white color. Tree productive, uniform, and symmetrical in growth.

*Ford's Improved Soft-Shell* (Plate X, Fig. 6)—Originated in 1877 by Mr. George W. Ford, of Santa Ana, from seed he obtained in San Francisco, and supposed to have come from Mr. Joseph Sexton, of Santa Barbara. Out of the twenty-five pounds of walnuts he obtained, one hundred of the largest and finest nuts were picked out, and from these twenty large nuts selected. These were planted, and from which originated this new improved nut. The nut resembles the Soft-shell. It is a large, clear nut, separates easily; the meat is very white, and the tree is a handsome grower.

*Ford's Eureka* (Plate XI, Fig. 6)—Originated by Mr. George W. Ford, of Santa Ana, from soft-shell nuts procured from Mr. Joseph Sexton, of Goleta. The nut is almost round, meat white, and very fine. Tree vigorous, and a fine grower.

### ORIENTAL VARIETIES.

Among the most beautiful trees are the Japanese walnuts. Two varieties are known in this state, one (*J. Sieboldiana*) being grown for more than twenty years. While it has been grown successfully, its economic importance has not as yet been determined. The nuts differ greatly from the varieties of *J. regia*, and present curious forms; they are, nevertheless, valuable, for the kernel is oily and sweet. The tree is very handsome, requires no pruning, is a strong grower, and very symmetrical in form, which, with its large, glossy leaves, of extraordinary size, render it most beautiful and especially suited for roadways and avenues. The tree is also valuable for stocks, as they take easily and are always healthy and of thrifty growth.

*Japanese* (*Juglans Sieboldiana, Maxim*) (Plate X, Fig. 4)—This variety has been cultivated very successfully in this state for more than twenty years. It is a beautiful ornamental tree, indigenous to Japan. The leaves are of enormous size. The nut is small and elongated, quite hard, but with a sweet kernel; of very little commercial importance.

*Heart-shaped* (*Juglans Cordiformis, Maxim*)—This variety is also indigenous to Japan, and of recent introduction. The tree is similiar in appearance to *J. Sieboldiana*. The nut is small and "heart-shaped," with a sweet kernel, said to be easily extracted by boiling for five minutes and then cracking.

*Chinese* (*Juglans Mandshurica, Maxim*)—This nut is also of recent introduction, and is indigenous to Eastern Asia. Resembles closely the eastern butternut in habit of growth and foliage, and is said to resemble it in the form and appearance of the nut.

### PLANTING, SOIL, AND OTHER REQUIREMENTS.

There is considerable difference of opinion among growers as to the proper age to plant walnut trees in orchard. Many contend that trees of three years' growth are best, while others contend that the seed should be planted where the tree is intended to grow, that it should never be transplanted, as

in doing so certain roots, and especially the tap-root, have to be cut, which is detrimental to the growth and fruiting qualities of the tree. Others hold this practice to be a fallacy, and contend that the tree should be grown in the nursery until the sixth or eighth year, as is practiced in some countries.

The walnut does best on a moist, warm, sandy loam, well underdrained. It is a very vigorous grower, and requires ample root-room, vertically and horizontally, and unless this is furnished the tree will not do well. Soil, therefore, which has a hardpan near the surface, heavy clays, or soils which hold too much moisture, are to be avoided. A fairly light, friable loam, of good depth and easily worked, offers perfect conditions in the matter of soil for the walnut.

Hon. Russell Heath, of Carpintaria, says: "The walnut should be planted for profit and best results on deep, rich loam, with no hardpan, stiff clay, or impenetrable soil nearer than twelve feet. I would select locations naturally moist in preference to land requiring irrigation. A temperature of 60° to 80° in summer, I regard as more favorable than other localities, although they thrive and are profitable in much hotter places."

## PROPAGATION.

The raising of walnut seedlings is very simple, but great care and attention are required in all points bearing on the germination of the nuts. There are various methods used, but the most simple is as follows: The walnuts are placed in sand, preparatory to planting. A frame, consisting of twelve-inch boards set on edge, of any size desired, and resting on the ground, is half-filled with sand; the nuts are then spread thickly (four to six inches) and covered with about three or four inches of sand. The sand is kept moist, but not too wet, and in case of lack of rain is watered. An embankment of earth is made all around the frame to prevent the nuts from drying. They are examined from time to time, and as soon as the nuts indicate or show signs of sprouting they are taken up and planted in nursery rows, from twelve to twenty-four inches apart. After the first and second years' growth the plants are of a suitable size to bud or graft, or are left in the nursery as seedlings until large enough to transplant into orchard form, the second or third year.

## BUDDING THE WALNUT.

There are several methods of budding the walnut, among which the following, by the writer (published in 1890), has proved very successful: Trees are budded in July, August, and as late as September. The bud is cut (shown in Fig. 1) about one and one-half inches long. In cutting the bud from the stick the cut is made deep into the wood, the object being to give the bud as much bark as possible. The wood in the bud is then partly removed; it is gouged out with the sharp point of the budding-knife. This is done to allow the inner bark of the bud to unite with the inner bark of the stock, which union would be prevented if the wood in the bud should be allowed to remain. After the wood has been partly removed (as shown in Fig. 2), the bud is inserted into the slit made in the stock, the same as is done in the ordinary

1. 2.

ROOT-GRAFTING THE WALNUT.

1. Root, with cion inserted, ready for waxing.
2. Root grafted, tied, and waxed over, ready for planting.

method of budding practiced on fruit trees. The bud is then tied tight with heavy budding twine of at least eighteen-ply. Three weeks or so afterward, if the bud has "taken," the twine is untied and tied over again; this is done in order to prevent the twine from cutting into the bark. This, however, is not required to be done if the trees are relaxing in growth, or are of such age as to have a bark thick enough to stand the pressure without injury. On young and thrifty growing trees it is best to loosen the twine at the third week, and it should be removed altogether at the fifth or sixth week. The buds are then allowed to lie dormant until spring, when the stocks are cut back to force the bud to start in the month of March or April, according to

Fig. 1—The bud, front view.

Fig. 2—The bud, transverse section.

Fig. 3—The bud, side view.

locality. As the walnut does not put forth until late in the spring, walnut stocks should not be cut back until they show indications of a rise of sap: with me this has been the most successful time. As soon as the stocks begin to put forth they are cut back and the buds allowed to grow. In cutting back the stocks great care must be exercised. They must not be cut back too close to the bud so as to endanger it, as the stocks invariably have a tendency to die back at the tip, at least an inch or more. As the buds start they are allowed to grow at will until they become hardy; they can then be trained to the remaining portion of the stock or to a stake, in order to produce a straight tree. After the first year's growth they can be transplanted to orchard form.

ANNULAR OR RING BUDDING.

This method is one of the simplest and safest to use on the walnut, and especially adapted to young trees of two or three years old, and to smooth limbs of large trees. In this method a ring is cut right around the stock, about an inch long. Then a ring of about the same size is taken from the scion, containing a bud, which is slipped into the corresponding space in the stock, and then bound tightly with soft cotton twine or cloth, covering it up to exclude the air. The operation should be performed when the trees are in full growth, during July, August, or September, and left to lie dormant through the winter, to be started in the spring.

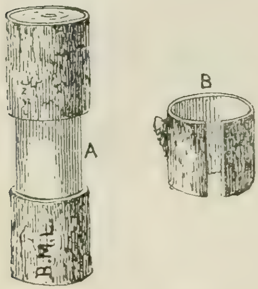


Fig. 4—*A*. The stock prepared. *B*. The bud.

GRAFTING THE WALNUT.

Walnut grafting is not as easily performed as budding. Great care must be exercised in the time and manner in which the operation is performed. The walnut, as a rule, cannot be grafted successfully by the ordinary methods practiced on fruit trees. The reason is that the scions contain but little wood, the pith in them being much greater than in scions of other trees; and when the scion is prepared (wedge-shaped) very little wood is left in it, and the bark is so thin that, when inserted, it cannot unite with the stock, not being held firmly in position. Terminal shoots, however, have a thicker bark and more wood, and are most successful in grafting. Side-grafting is accomplished with success, but can only be performed in the spring, when the sap in the stock begins to rise; this is necessary, as the scion must be inserted when the bark peels, in the same manner as a bud. The walnut does not put forth until quite late in spring, and to secure good, firm wood it becomes necessary to gather the scions before the trees start; and that they may be kept dormant, are covered with moist sand and placed in a cellar or cool place. In this way they can be kept until the stocks have made sufficient growth, so as to facilitate grafting. I have experimented in grafting the walnut for over twenty years, and the most successful method with me has been the prong graft or prong bud (of my own origin). (See Plate IX, Figs. 1 to 5, illustrating prong budding). In this method the small prongs found at the extremity of the shoots are used. (Fig. 2, Plate IX, illustrates the prong—scion—used, and how cut from the branch, reduced one-half). The prong is cut as a bud, as shown in the illustration, and the wood is partially removed with the point of a budding-knife, the same as in the method of budding herein described. The stock is first prepared by cutting off with a sharp saw and smoothing over with the knife; a vertical incision is made on the side, and the scion inserted and tied tight with strong budding twine of at least eighteen-ply. The cuts are waxed over with grafting wax. After the scion has started, the graft is examined from

1 2 3

GRAFTING THE WALNUT.

1. The cion prepared.
2. The cion inserted in the stock, ready for waxing.
3. A cion tied and waxed over; growing; three weeks after being grafted in the spring. From photographs; natural size.

time to time, and if it is found that the twine begins to cut into the stock, it is untied and tied again; this will prevent any injury to the stock or scion. The twine, however, should be allowed to remain as long as possible, as it prevents the bark surrounding the slit made on the stock from opening and unseating the scion, which is apt to occur from the action of the atmosphere causing the scion to dry out and die. When the scions have grown from six to twelve inches and assumed the functions of the top, this precaution is no longer necessary, and the twine is then removed altogether. The growth of the scions at this time, however, is very tender, and they may be broken off by the slightest touch; as a protection, it is well to drive a stake at their side, to which they are tied with some loose material or cloth strips. When this method is employed on large limbs, or on the tops of trees, it is well to tie a piece of limb or wood of any kind on the side of the branch and to which the growth of the scion should be tied. Another good protection is to take a piece of green shoot and tie both ends to the branch so grafted, forming a loop over the bud, to prevent birds, etc., from sitting on the graft and thereby disturbing it.

### CLEFT ROOT-GRAFTING.

One of the most satisfactory methods practiced on small walnut stocks is the cleft-root graft, and its application does not differ materially from the method practiced on pear and apple roots.

The small plants (only one-year-olds are used) are taken up and grafted indoors. (See Plate VII, Figs. 1 and 2). They are cut off at the crown and split obliquely and the scion (wedge-shape) inserted and immediately tied with six-ply or eight-ply budding twine or cloth, and waxed.* They are then heeled in sand in some convenient place, exempt from draughts and sunlight, as follows: On the floor of a propagating house or shed moist sand is spread out from six to twelve inches deep; then the grafts are put into it standing, thickly, and covered with sand. The entire graft to within an inch or two of the top is covered without injury to it. The sand should always be kept moist, but not too wet, as the bark of the graft is liable to decay; and again, the sand must not be allowed to get dry, as the bark of the graft will shrivel and avoid adhesion. They are kept thus stored from four to six weeks, during which time the parts (scion and stock) callous over; they are then planted in nursery rows, and soon after begin to grow.

### TRIANGULAR CROWN GRAFT.

Like the preceding method (cleft root graft) this, too, has proved successful. The stocks (a year old) are not split, but instead a triangular incision is made in the side of the stock, as shown in Fig. 5 at C, about one to one and a half inches long. At this point the wood of the stock is generally quite solid and the pith very small. This cut rather consists of taking out of the stock a triangular piece, into which space a scion is inserted of the same

*Only wax the parts cut or exposed, so that on planting the string or cloth on the parts not waxed may decay and not bind the stock. It is also advisable to cut the twine or cloth on planting.

shape and size. D shows the space ; A the scion prepared for insertion. The scion (from terminal shoots preferred) is prepared to fit the corresponding space, as shown at B, and fitted into the cleft. It is then tied with cloth or twine and waxed over.

This method is also employed with success in the field. The earth is removed from around the stocks and the tree is cut smoothly about the crown or where the swelling of the root begins. The graft being inserted, it is tied with cloth, and waxed. The soil is then banked up against it, covering the graft and stock to within an inch or two of the top of the scion. For making the cleft and facing the scion it is important that the knife be sharp to make a smooth cut. This operation (in the field) is best performed, and most successful, when the stocks begin to show signs of growth late in the spring. The scions are cut late in the fall, or early spring, and kept in sand preparatory to using.

### CLEFT SAP GRAFT.

Much credit is due to Mr. Felix Gillet, of Nevada City, who has experimented with all sorts of grafting on the walnut for many years, for having given the public the results attained by him in the use of this method. The operation is performed early in the spring when the sap is commencing to flow, and can be used on large limbs from three to five inches in diameter. The limb is sawed off and smoothed as for ordinary cleft-grafting ; instead, however, of making a single cleft through the center, two are made, one across the stub at each side of the center, the clefts then being in sapwood instead of through the heartwood and pith. The scion is prepared as for ordinary cleft-grafting, for which purpose it is best to use terminal shoots. In cutting the scion great care must be exercised to cut only into the pith of one side. The scion having been inserted, the wound is bound well with cotton cloth and thoroughly waxed.

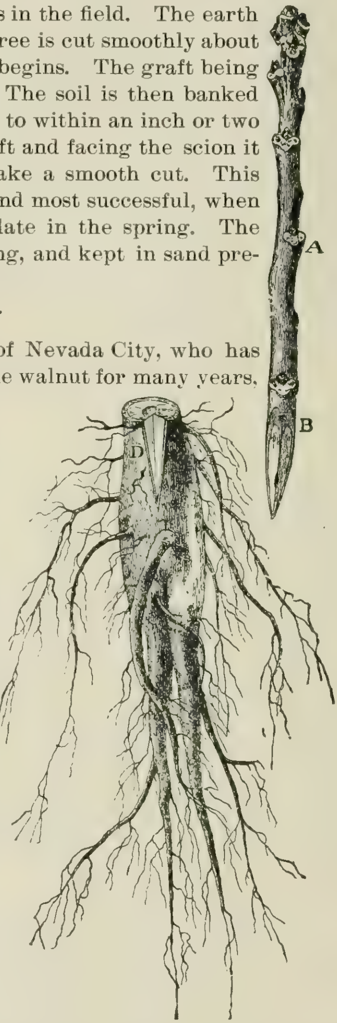


Fig. 5.

### THE BLACK WALNUT.

(*Juglans Nigra*, Linn.).

The relative merits of the Black walnut for stocks to graft unto have been under consideration for many years, and this root has been extensively tried in this state, with satisfactory results. The variety mostly used is the *Juglans Californica*, or California Black walnut. (Plate X, Fig. 11). In a few instances *Juglans Americana*, or eastern Black walnut (Plate 10, Fig. 9),

1. Prong-bud growing, showing the stock where first cut back and waxed over; also the twine tied loosely to prevent the opening of the bark and endangering the bud.
2. The bud prepared, ready for insertion into the slit in the stock.
3. The stock prepared, ready to receive the bud.
4. The bud inserted, before being tied.
5. The operation complete. From photographs; natural size.

has been tried, but preference was given to the former, being indigenous to our state. The Japanese walnut (*Juglans Sieboldiana*) has also been tried, and has proved quite satisfactory, but is not as strong a grower as the *Californica*. For a time I was loath to believe the stock would influence the graft and cause it to produce nuts of a dark shell. Experiments, however, have proved the contrary. Trees now in bearing for over twenty years show no variation in color of shell, but an improvement in kernel and quality of the nuts. The stocks are thrifty and healthy, easy of propagation, and easily budded and grafted. Some twenty years ago I commenced experimenting in grafting and budding the wild walnut, with very satisfactory results. A plot of *Juglans rupestris*, growing along the mountains in Los Angeles County, was worked over to different varieties very satisfactorily, but the stock is quite scrubby and of such dwarf habit, that it can only be recommended for dwarf purposes. The grafts took well and made splendid growth. In all tests made on trees in the wild state, nuts were produced on buds and grafts the second and third years. In some cases the nuts were quite small, due perhaps to the stunted condition of the stocks, for all must have been very old. The buds and grafts that made the strongest growth were on stocks which did not look so aged. These are now producing fine nuts, equal to those from the parent tree.

The oldest walnut orchard budded on the *Californica* is at Winters, Yolo County, and the trees are over twenty years old. This orchard has produced fine crops yearly and the nuts show a marked improvement over those produced by the parent trees.

At Vacaville two rows of large Black walnut trees (*J. Californica*) were worked over to different varieties of the English or Persian walnut very successfully, by the prong bud method, described elsewhere, and the ordinary cleft sap graft. The trees were planted some thirty years ago for shade along the roadside. In the winter of 1892 the limbs were cut back to the crotch or main stem. In the spring they put forth numerous shoots, which were thinned out to a dozen or so to each tree, according to the spread of the branches. These new shoots were budded in the summer. Those that did not "take" were grafted in the winter. Thus a fine stand of buds and grafts was obtained, which commenced to bear the second and third years. They now form large spreading heads, and bear regularly.

The process of converting these apparently worthless trees, except for shade, into fruitful trees, was very simple, and has proved remunerative and entirely satisfactory to its projector.

In Ventura County are to be seen many walnut orchards of recent planting, budded and grafted on this stock. This was brought about by the satisfactory results obtained from walnut orchards so worked of early planting. In the past few years large plantings of walnuts have been made, and many growers have given preference to trees grafted and budded on this stock—*J. Californica*.

## PRUNING THE WALNUT.

*"During the first year constant pruning is necessary to have the tree properly shaped. I have pruned in a summer as many as four or five times. Branches are apt to grow too rapidly, bear down with their own weight, and break off during high winds, destroying the symmetry of the tree and occasioning much loss of time. All lateral branches growing from the leader should be cultivated to assume an upward angle of about 15° to 45° from the main leader. This can be done by clipping off all branches growing under, and at times cutting off the ends. A trunk should be maintained free from limbs three and one-half to four and one-half feet from the ground. Earth should be kept away from the trunks, and if the top roots near the trunk are exposed, so much the better; it will assist the tree in breathing. The most careful cultivation is necessary, and nothing, after the fifth year, should be grown between the rows, unless you have plenty of water to irrigate by flooding all the ground once every eight weeks; if you are so prepared, sow your orchard in alfalfa, and do no cultivating."

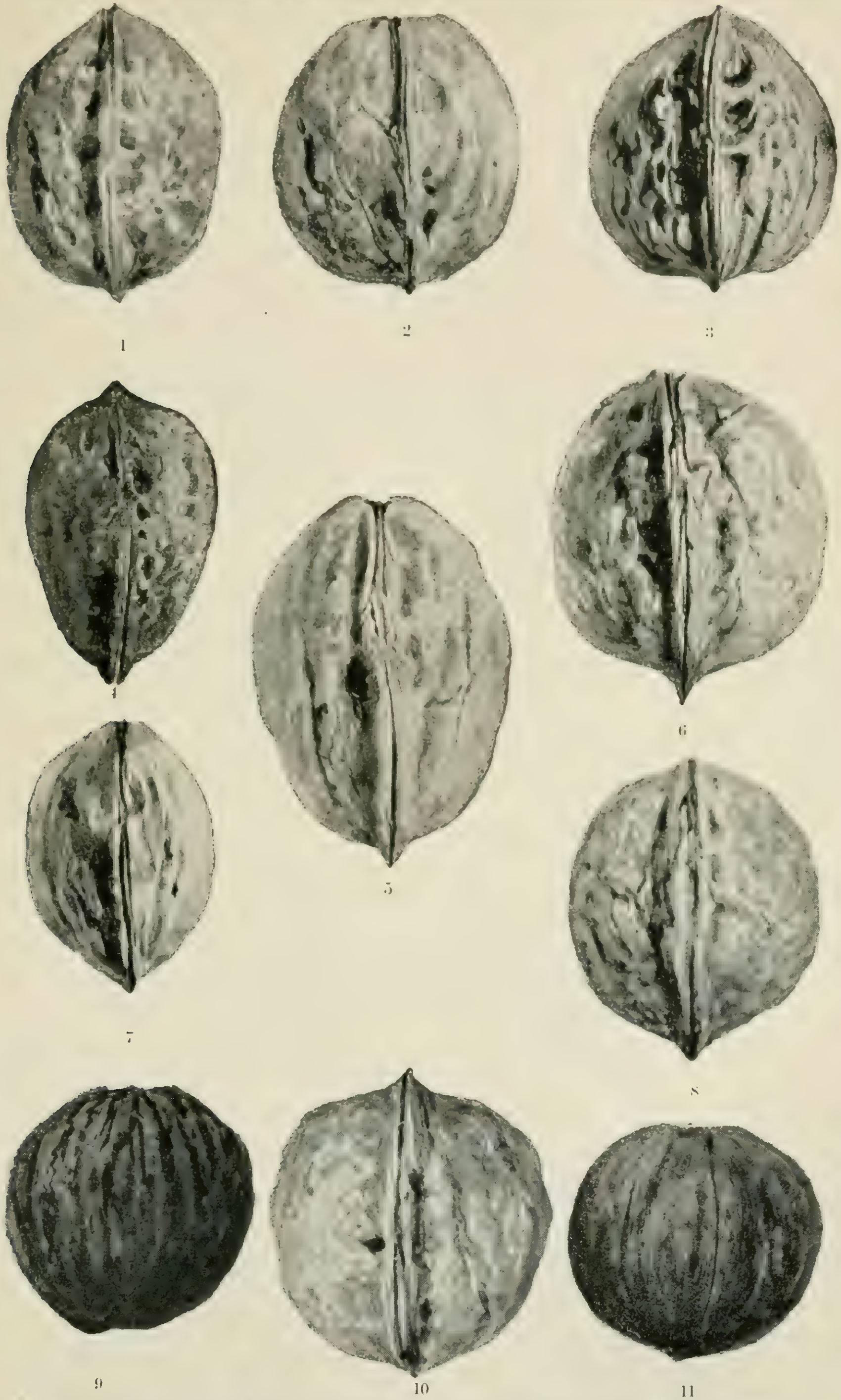
†"Pruning the walnut is extremely simple and can be done by any one. When planting the tree, don't cut the top off of one-year-old trees, but it is absolutely necessary to cut back a two or a three-year-old tree; in fact, the finest young walnut orchard I know of in Orange County (and we have lots of fine ones down this way) was grown from two-year-old trees from eight to ten feet high, and cut back to about four and one-half feet, and all limbs below that trimmed off, except three or four, which were allowed to grow up and make the top of the tree. Never prune the trees over three and one-half feet, as the bark of a tree is easily sunburned, and thus it is necessary for the foliage to shade the trunk. If the lower limbs extend outward and are in the way of the cultivator, tie them up, for by so doing you can train the lower branches upward, so as to cultivate close to the tree, and when the orchard comes into bearing the limbs growing upward will not bend down to the ground with the fruit, so you cannot get within twenty feet of them with the cultivator."

‡"In pruning it has been the custom to trim to a height of six to seven feet, but I think four to five feet better. Such high pruning makes the tree top-heavy, and the prevailing winds cause them to lean, exposing one side of the trunk to the sun, thus causing sunburn. I think it is best to trim little, if any. It is the nature of the tree to allow the limbs to grow downward and fill any space of account that may have been made by pruning, while if allowed to grow in their natural state, the limbs will start near the ground, growing upward and keeping out of the way much better than when allowed to hang down. I have not been able as yet to grow them just as I would like in this respect, on account of raising crops (mostly corn) between the trees, and I find it very difficult to save the lower limbs while young and tender, as a very little push or strain when plowing will injure them next to the trunk, and they should then be cut off to save the tree from greater injury than the loss of a limb. Avoid crotches or forks. If a tree is about evenly divided the abundance of foliage the tree has in summer will cause it to split with a very little wind, and you will thus loose the use of the tree for several years, if not altogether. If badly broken, start a new shoot near the ground, and in six years, with care, it will be a bearing tree."

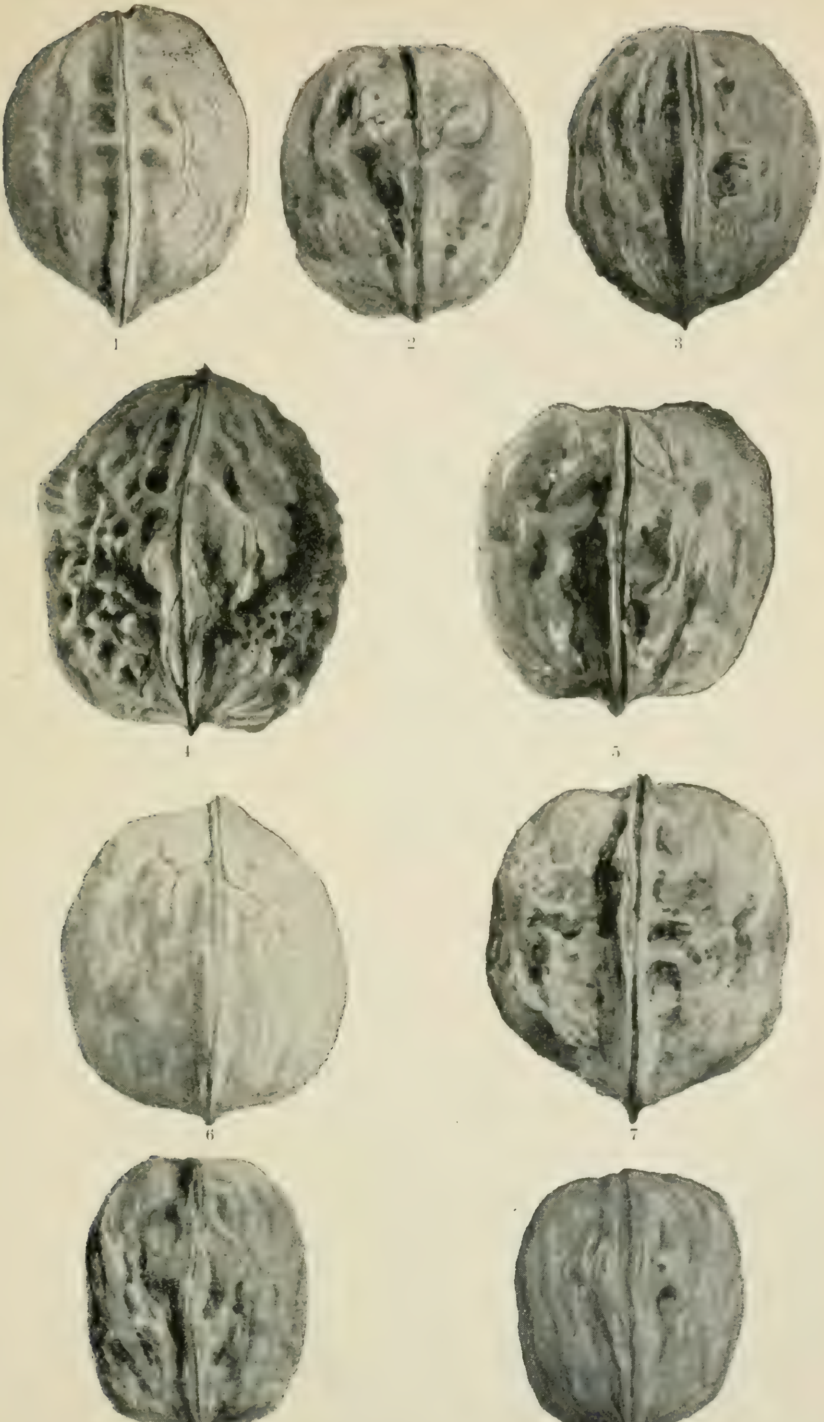
## HARVESTING.

Harvesting the walnut is very simple, as most of the nuts do not have to be picked, for they, of their own accord, drop to the ground at maturity:

*Hon. Ellwood Cooper, Santa Barbara.
†George W. Ford, Santa Ana.
‡C. A. Caufman, of Rivera, in *California Cultivator and Poultry Keeper*, October, 1896




EXPLANATION.—1. California Paper-Shell. 2. "English" (so called). 3. Mayette. 4. Japanese (J. Sieboldiana). 5. Franquette. 6. Ford's Improved Soft-Shell. 7. Cluster. 8. Rivera Soft-Shell. 9. American Black (J. Americana). 10. Improved Soft-Shell. 11. California Black (J. Californica).




EXPLANATION.—1. Fertile. 2. Mobart. 3. Serotina (St. John). 4. Gant (Syn. Bijou). 5. Grenoble. 6. Ford's Eureka. 7. Rivera Hard-Shell. 8. Præparturiens. 9. Charberte.

yet, considerable attention must be paid to the gathering of the crops so as to have clean, bright nuts that may command a high price and ready sale. The walnut harvest begins in September and ends in November. In some sections the crop comes in quite early, and is gathered in September, overlapping into October: in others, the crop is not harvested so early: but October is the principal month, sometimes overlapping into November.

Some of the growers collect the nuts from the ground as they fall every day, others collect them every other day, and some every third day, until most of the crop has fallen of its own accord, and those remaining on the trees are knocked down by means of a pole. Boys and men are also employed to climb the trees and shake the nuts down: others agitate the limbs with a pole having a hook on the end. The nuts that are ready to drop come down easily, and are picked up and dried on trays in the sun. It generally takes from three to four pickings to gather all the nuts from a tree. When the husk inclosing the nut shows no sign of cracking it is an indication that the nut is yet unripe, and when knocked down the kernels of many of these generally dry away and do not fill well. Then, again, if the nuts are allowed to hang on the trees or remain on the ground too long after falling, they absorb moisture and rapidly deteriorate in flavor, color, and keeping qualities. In the walnut sections along the coast damp fogs and dew prevail during the harvest time, rendering the husks quite moist, and the nuts contained inside become stained by the acid juice of the husks, which, if not removed, renders the nuts quite black, and lessens their market value. This acid is very strong and adhesive, and to remove it the nuts have to be washed and afterward dried. Hon. Ellwood Cooper, of Santa Barbara, has a most perfect apparatus for washing and drying the walnut, which is an invention of his own. It consists of an iron cylinder with a long opening on the top side, where the nuts are put in. When the nuts are washed the cylinder will turn with the opening down, thus letting the walnuts and water out. As with all other apparatus of this kind, it has to be seen to be appreciated. They are made by the Fulton Iron Works, of San Francisco, and cost from $125 to $140.

* "There are different modes of gathering: some clean the trees but once, and others go over them several times. I pick what has fallen without knocking. I then tap those limbs lightly on which the nuts are ripest, and the third time over I aim to clean the trees. The walnuts are picked up and put in sacks and barrels, so as to be easily handled, and hauled to a sunny place to dry, and should be placed on elevated platforms made of narrow boards, with spaces of one-fourth of an inch between each board. The platform should be about eight feet wide and forty feet long, or as long as two men can handle a canvas to cover the beds, which should be done every night the dew falls. The nuts should be stirred in these beds once or twice each day, and with favorable weather they will dry sufficiently in three days, and are ready for market. I have always dried my walnuts by the sun and they have given good satisfaction, and for small orchards I think it the cheapest and best way. Some dry by evaporation and claim it is preferable to the sun: that it sets the oil quickly and prevents the nut from becoming rancid. Others claim that it makes them so; but, be this as it may, those

*Joseph Sexton, essay before Ninth State Fruitgrowers' Convention, 1888.

having large orchards cannot depend on drying all by natural heat, and the drier will have to be used, even if it is not so good for the nut."

* "In handling the nuts, I cure in dryhouses by artificial heat, heating sufficient to evaporate the water and set the oil of the nut. When this is done the nuts will keep sweet for an indefinite time. I have kept them as an experiment, in my storehouse, which is of concrete, for five years, and at the end of that time they were as sweet as when first cured. With my facilities, I cure them in eight hours. In preparing them for market, I have a washing apparatus—invented by Mr. Cooper—which I use if the nuts are discolored, as they often are by coming in contact with leaves or shucks when there is dew or rain. Directly after washing they are thoroughly dried and cured in the dryhouse."

# CHESTNUT HARVESTING, PRESERVING, AND PREPARATION.

By Felix Gillet.

The question of how to preserve, handle, and prepare chestnuts, since the cultivation of that nut seems to be increasing all over the Pacific Coast, is both an important and interesting one to discuss. It has been often put to me, as a propagator of that species of nut, and more recently by yourself, as you have requested me to reply to the inquiry made by P. B. Schmidt, one of your correspondents from Calistoga, reading as follows:

> Kindly inform me through your valuable paper what is generally done with Italian chestnuts, after picking, to prevent moulding? We have dried ours lightly in the oven, the outside air no longer being warm enough for drying them; but this did not prevent the rotting of a great many. Is there any particular process gone through in Italy or elsewhere whereby the nuts are prepared for the market?

I will answer this inquiry as clearly as I can, giving you at the same time some new facts on the subject of chestnut culture, treated by me heretofore in the columns of the *Pacific Rural Press.*

*Harvesting of the nuts*—The proper way of gathering chestnuts has much to do with their preservation. The nuts generally ripen in October; here, in our mountains, mostly in the middle of October to the first of November. When time of ripening approaches the burrs turn from green to yellow, darker at the center, where they finally crack open, showing the brown hulls of the nuts inside; the nuts dropping to the ground when the burr is fully open, or the wind shakes them down. The nuts, to insure their thorough ripening, should be allowed to drop out of the burrs themselves for two weeks or more, they being picked from the ground every morning and put immediately to sweat; after that time the remaining burrs and nuts are knocked off the trees by striking the limbs with long, flexible, and slender poles, the same as is done with walnuts. A little wooden mallet is

*Hon. Russell Heath, essay before Eleventh State Fruitgrowers' Convention, 1889.

generally used to open the burrs falling to the ground and which do not burst open naturally, or yet holding one or two nuts. In European countries, where chestnuts are grown on a very large scale, women generally do the harvesting, using to that effect a forked stick to rake off the leaves that cover the nuts, the same stick being used to force the nuts out of the burrs, which are put in a little basket and then emptied into sacks, to be afterwards hauled away to the sweating grounds or shed.

*Sweating and drying of the nuts* — Whenever chestnuts are intended to be eaten as a dessert nut, either roasted or boiled, they have, before being placed on the market and sold as fresh nuts, to go through a certain sweating process to take out of them their vegetation water and so prevent them from moulding and rotting; that operation has to be done at once, to prevent the mould from getting a start. The larger the nuts are the more important it is to dry them properly; for instance, Marrons, the largest chestnuts grown, will require more time to sweat than the smaller nuts of the Italian and Spanish kinds, propagated solely from the seed on this coast. An evaporator or dryer, whenever one is at hand, can very well be used, but used intelligently, in drying chestnuts, for it would not do to dry them too hard. In Europe they simply place the nuts on ordinary trays made of willow, or trays with a wooden frame and screen bottom, so as to permit the air to get around the nuts, the trays being placed under the roof of a building opened at least on two sides, or in the shade, where the sun does not shine on the nuts; but wherever there are heavy dews at night the trays have to be stacked, one on top of the other, or put under the roof of a building until morning. According to size, chestnuts require from one to two weeks to dry sufficiently to keep, when they are then taken to market in sacks and sold fresh. But, if cured in a kiln or evaporator, it would take much less time, and I have an idea that nuts so dried would show a less percentage of moulded ones, because the operation of drying, instead of going on gradually, would be done at once. I use prune trays, which are quite handy, for the drying of my crop of chestnuts. One can easily tell when the nuts are cured, for the shell must feel a little loose to the touch; that is, the meat somewhat shriveled, but fresh. Whenever the nuts have to be used at once they are taken to market after a couple of days of natural sweating; such ones are the best for roasting, but not so sweet as when they have been put to sweat a longer time. When chestnuts have been properly dried they will keep well in sacks or barrels for future use; to keep them a longer time they should be put in very dry sand and in a dry room, being taken out of the sand as fast as they are wanted.

For the manufacture of meal or flour, chestnuts have to be dried hard and every particle of pelicle removed; they then have a white appearance and are what is called "bleached." Bleached nuts keep indefinitely if stored in a dry room. A kiln or dryer would be the thing here on the Pacific Coast to dry chestnuts hard for the manufacture of chestnut meal, which, cooked with milk, makes a delicious mush.

*How to prepare chestnuts* — French and Italian chestnuts are always eaten cooked, that is, either roasted or boiled. They can very well be roasted in

a deep fryingpan with numerous holes in the bottom, being shaken constantly to prevent burning. The shell and pelicle of roasted chestnuts come off very nicely. The fresher the nuts are the better for roasting purposes. Chestnuts can be roasted on a small scale by placing five or six at a time on the hot kitchen stove with a tin cup over them, turning them once in a while until cooked. But before roasting chestnuts one has to be very careful to make an incision with a knife at the sprout or small end, to prevent the shell from exploding and scaring the whole house.

Boiled chestnuts are also a fine dish. The shell has first to be removed, a pointed or pocket knife being best for this purpose. The nuts are then placed in a deep saucepan with water, salt, and a sprig of celery. If the nuts are fresh picked it will take but one hour to cook them; but if a little dried, as when after they have gone through the sweating process, they would require from one and one-quarter to one and one-half hours to cook. Boiled chestnuts should be eaten when right warm, as the pelicle then comes off very easily. Immense quantities of boiled chestnuts are eaten in the chestnut-growing regions of Europe. They are also extensively used for stuffing turkeys, geese, and chickens. This is the way our Thanksgiving turkey was stuffed with Marron chestnuts: The stuffing should be done one day in advance, the nuts being duly cooked in boiling water and peeled off, and the sausage meat to go with them previously fried, the liver, gizzard, and heart of the turkey being cut up fine and mixed with it before frying. The chestnuts and sausage meat might be put inside the turkey separately: better, I think, to have both mixed. Such stuffing is really fine. As chestnuts can very well be kept until Christmas, as described in the course of this paper, such stuffing can be employed with the Christmas turkey.

*Marron chestnuts*—For dessert, that is, to be eaten either roasted or boiled, Marron chestnuts command the best prices on account of their size and beauty. As the term Marron does not seem to be well understood here, I will describe its true meaning. In Bulletin No. XLII of the Delaware College Experiment Station, issued in December, 1898, I read under the head of "Spanish Chestnuts:"

Marron, Mammoth Sweet Spanish, French Marron, and the like, a general name for European chestnuts with no varietal significance. "Marron" is the French name for the cultivated chestnut.

Good gracious! What a definition for the famous Marron de Lyon, Marron Combale, and the fine commercial varieties of France! It would be well, it seems to me, for the writers of agricultural college bulletins to become better acquainted regarding the subject they treat before trying to enlighten the public themselves. "Marrons" are chestnuts, it is true, but all chestnuts are far from being "Marrons," and many of the cultivated varieties in Europe are not Marrons, neither, but mere seedlings. Marrons are varieties of chestnuts yielding only one to two nuts to the burr, sometimes three, but never four to eight, as is the case with seedlings. Hence the reason why Marrons are invariably propagated by grafting, as they very seldom come true from seed. It explains, too, why the nuts are so large and round, or flat only on one side, therefore the best marketable nut for dessert.

Marrons are more or less productive. The Marron de Lyon, the one that produces the greatest number of nuts with one nut in the burr, or round nuts, is a shy bearer, while Marron Combale and Marron Querey, for instance, which produce nuts singly and in pairs in the burrs, are enormously productive. I have a tree of Marron Combale on my place, now thirty-three years old, and a photograph of which was reproduced in the *Pacific Rural Press* of December 31, 1898, that bore one hundred and thirty-six pounds of nuts that year, while this year (1899), and when everything, including apples, was killed on the night of April 27, the same tree bore one hundred and fifty-three pounds of magnificent nuts, just showing how hardy and productive are those French varieties of Marron chestnuts.

*Blooming of the chestnut*.—Before closing I would like to call the attention of the owners of chestnut trees who complain that their trees are bearing lots of empty burrs, that it is no defect of the trees or the variety for acting that way, as I will explain. Fruit and nut trees in general drop the blossoms or embryo fruits that have not been fertilized, for nature never intended to have all the blossoms perfect, as it would be fatal to the longevity, if not the life, of the tree. But with the chestnut the case is a different one, for at blooming time all the pistillate flowers will develop a burr which, whether fertilized or not, will hang on the trees, with this difference, that the unfertilized burrs will grow of a lesser size than the perfect one, but shed at the same time in the fall. How many young fruit trees we see covered with flowers in the spring, but finally, having but few fruits on, all the balance having dropped off, for the trees would be really unable to bear and ripen a larger crop! So it is with chestnut trees, and because the unfertilized or empty burrs fall at the same time as the perfect ones, when the nuts are ripe, is no reason why they should all be full of nuts. When a tree of the size of the Marron Combale, as represented in the *Pacific Rural Press*, yields one hundred and fifty-three pounds of nuts, it is immaterial if ten per cent. or more of the burrs are empty. At any rate, the larger and older the trees the fewer the empty burrs found on them.

# PREDICTION OF FROST.

By Prof. J. E. Bonebright, Moscow, Idaho.

The fruitgrowers, especially those who live in valleys, often experience serious losses by late spring frosts. If warned in time it is usually possible to prevent the frost, but owing to local conditions, and the effect of valley and mountain atmospheric currents, it often becomes impossible to predict, from an evening temperature, a frost during the night.

It is the purpose of this article to describe a piece of electrical apparatus which will give warning when the temperature has dropped to a certain limit.

The prevention of frosts by smudging is well known to most fruitgrowers, but for those who may have had little experience in smudging the following paragraph is given.

## PREVENTION OF FROST.

There are several different methods of preventing frost, but the most practical is the smudge or smoking fire. The object of the smudge is to form a smoky vapor cloud which prevents the radiation of heat from the ground and thus keeps the temperature above the frost point. As no appreciable amount of heat is derived from the smoke, the smudging, which prevents the air and earth from losing heat, must be begun at a temperature above freezing. If the work were begun at a temperature of 40° F. the ground could be protected for several hours. In order that the smoke should cover the ground the smudges should be placed from one to two rods apart on the windward side of the spot to be protected. A good smudge can be made from a pitchy pine stump or log. In the stump vertical and horizontal auger holes are bored so that they meet each other at right angles. A little coal oil is poured in the vertical hole, and a match applied to oil and wood at the horizontal opening. The holes act as a chimney, causing a current of air to pass upward through the stump. The stump should be four feet or more in height, and at least one foot in diameter, and of a pitchy character and not too dry. The horizontal hole should be near the ground. If the stump is large it will serve two or three nights. As it burns it may become dry and begin to blaze, in which case a little water should be thrown on it; for the object is to produce a smoky cloud and not to use the heat from the blaze. Damp straw or manure will make a good smudge. During the season in which the damaging frosts occur it is desirable to keep the stumps or straw ready for use at any time, and, for this reason, the stumps are to be preferred, since they are not affected by the weather.

## LOW TEMPERATURE AND FROST.

A warning of a low temperature during the night is not necessarily a prediction of frost. Thus a warning of 40° F. near sunrise, and especially if the sky were clouded, would not mean frost; while, on the other hand, the same temperature at an early hour in the night, with a clear sky and no wind, could be taken as a warning of frost before morning. And, in order to make use of the heat remaining, smudging should be begun. These remaks can only be taken for average conditions, for much depends upon local features, such as elevation, slope of the land, bodies of water, and cold-air currents. With a little experience and a knowledge of his ground the practical man can always be on the safe side.

In order to protect against frosts, a warning should be given when the temperature has fallen not less than 8° or 10° F. above freezing. For this purpose a nightwatch is often employed. Thermostats have been used for the same purpose. Neither method is desirable, as the nightwatch adds to the labor and expense of raising the crop, and the thermostats have not proven very reliable. See Fig. 3.

The apparatus described in the following pages will give warning, by the ring of a bell, when an exposed thermometer has fallen to a given temperature, and can be placed anywhere in the orchard or field. The other parts can be put in the house with the warning bell in a convenient place. The entire cost of the apparatus is from $5 to $7. From the following description any electrician can make the apparatus, and a person not acquainted with electrical methods can put it in place.

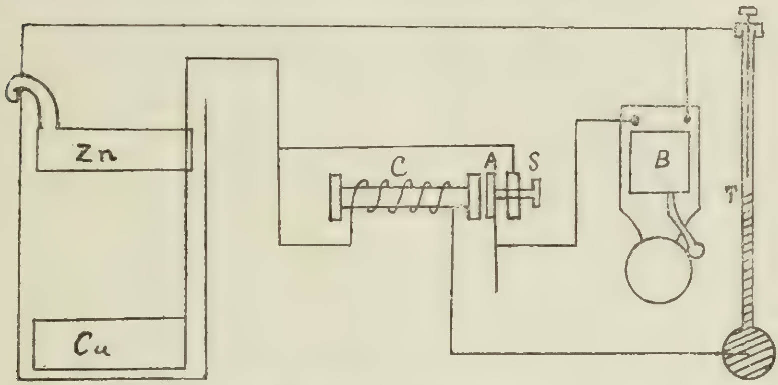



Fig. 1—Electrical apparatus.

## DESCRIPTION OF APPARATUS.

The apparatus consists of a battery, relay coil, alarm bell, and thermometer. The battery used is the common crowfoot cell used in telegraphing, size six inches by eight inches.

The relay C (Fig. 1) is composed of two coils. Each coil has an iron core one and one-fourth inches long, one-fourth of an inch in diameter, and is wound with No. 24 B. and S. double cotton-covered magnetic wire, to a depth of one-fourth of an inch. The coils are wound right and left-handed and are placed horizontally.

The armature A consists of an upright piece with a crossbar of soft iron, which is so held that it is attracted by the iron cores of the coils when magnetized. An adjustable spring holds the armature A against the screw S, when no current is flowing through the coil C. The maker should put on the base of the coil binding-posts marked with the connections as given in Fig. 1. A fifty-cent doorbell will answer for the alarm.

The thermometer consists of a glass stem eight or ten inches long, with an internal diameter of approximately one-twenty-fifth of an inch (one centimetre) attached to a bulb which has a diameter of one inch (twenty-five centimetres). The bulb and two or three inches of the lower part of the tube are filled with mercury and the tube is graduated for every ten degrees from 30° F. to 100° F. Electrical connection with the mercury is made by a platinum wire blown in the glass. On the top of the stem is a brass cap with a No. 30 B. and S. bare copper wire passing through it and making contact

with the mercury. The thermometer can be tested at any time by comparing it with an accurate Fahrenheit thermometer. It is made large in order to give free action to the mercury around the wire in the tube.

### TO PUT THE APPARATUS IN PLACE.

To prepare the battery, place the copper and zinc in a glass jar as in the cut, and put copper sulphate crystals (blue vitrol) in the jar to the depth of an inch. Fill the jar with water, being sure to cover the zinc and connect the wire from the copper to the zinc. At the end of twenty-four hours the battery will be ready for use. The battery can be prepared for immediate use by filling it to the zinc with water and then covering the zinc with the solution, surrounding the zinc of a similar battery, which is in good running condition.

The thermometer should be freely exposed not more than two or three feet above the ground in that portion of the orchard most liable to frost, usually the lower ground.

The lower point of the copper wire in the tube of the thermometer should be set opposite the number indicating the temperature for which the instrument is to give warning, usually 40° to 45° F. A copper wire No. 16 B. and S. connects the wire in the stem of the thermometer to one post of the bell and to one pole of the battery, another wire connects the mercury in the bulb with the proper binding-post of the coil, and a third wire is run from the armature of the relay to the remaining binding-post of the bell. The remaining pole of the battery is then connected to the properly-marked post of the coil. It is well to test the connections by seeing that the bell rings when the thermometer circuit is broken.

The action of the instrument is very simple. When the wire in the stem of the thermometer is in contact with the mercury a current of electricity will pass through the relay coils, causing the armature to be attached to the iron cores. The battery furnishes a continuous current and will keep the armature in this position until the circuit is broken. When the circuit is broken by the mercury falling below the lower point of the wire in the thermometer the armature will be drawn by the spring against the screw S, which puts the bell in a circuit with the battery. This condition is shown in the cut. The wires used in connecting up the aparatus should be insulated by fastening them to wooden supports. It should be noticed that the bell will give warning of the breaking of one of the wires leading to the thermometer. In case the thermometer is more than one hundred and fifty feet from the battery, two cells should be connected in series, i. e., the copper of one cell connected with the zinc of the other. In any case where one cell is not strong enough, two in series should be used.

Since the instrument can be set for any temperature, it can be put to practical use in the greenhouses, incubators, and in any place where a warning of low temperature is desired.

DIFFERENTIAL THERMOMETER.

The differential thermometer consists of a glass tube with one end open and the other closed with a bulb. The lower part of the tube is filled with mercury and the bulb contains alcohol. As the temperature rises the alcohol expands and the mercury rises in the open tube. When the alcohol contracts the atmosphere forces the mercury into the closed tube. The instrument is usually provided with two scales with the orders reversed as shown in the figure. By having a platinum wire blown in the bend of the tube and putting a wire in the open tube this thermometer can be substituted for the thermometer of Fig. 1. If the instrument is to give warning of one

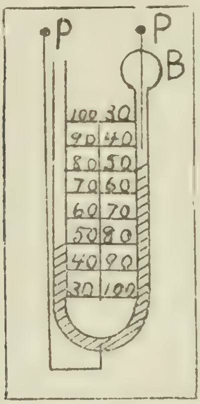


Fig. 2—Differential Thermometer.

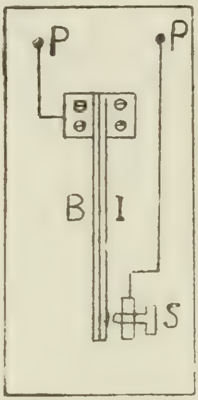


Fig. 3—Thermostat.

temperature only, and is not to be adjustable, the coil of Fig. 1 can be dispensed with by having a platinum wire blown in the bulb of the differential thermometer with the lower end of the wire opposite the required temperature. In this case the battery bell and differential thermometer are connected in series, i. e., so that the current flows when the mercury touches the wire blown in the bulb of the thermometer.

THERMOSTAT.

Fig. 3 represents one form of the thermostat, of which there is a great variety. It consists of brass and steel rods fastened together. The brass expands or contracts more with a given change of temperature than the steel and thus the rod bends as the temperature changes. In the figure I is the brass rod and B the steel rod. With a lowering of the temperature the rod will bend toward the right until it touches the screw S, which is set at the required temperature. It is connected in series with the battery and bell. A very slight derangement will make the thermostat useless, and, for practical uses and accurate results, it is not so desirable as the thermometer.

The writer would be pleased to correspond with any one wishing further information on this subject.

# FROST.

## WHEN TO EXPECT IT AND HOW TO LESSEN THE INJURY THEREFROM.

By Prof. W. H. Hammon.

### FORMATION OF FROST.

Before proceeding to a consideration of methods of preventing injury by frost, it is essential that the conditions under which it forms be quite thoroughly understood.

The two principal methods by which plants lose their heat are convection and radiation.

The movement of the air is continuously bringing new particles of it in contact with the plants, and if the air be cooler than the plants it will take from the plants a portion of their heat, until both air and plants are at the same temperature. This is known as convection, and is very effective on windy nights when a cold wave is approaching, and the breeze is continually bringing new portions of the atmosphere about the plants. We can hardly attribute to this process the great loss of heat on the quiet, clear nights when frosts mostly occur: for on such nights the plants are usually colder than the surrounding air, and any mixing of the air tends to raise their temperature.

The chief method by which plants lose their heat on calm, frosty nights is by radiation. By this term is meant that peculiar process by which heat escapes from an object and passes through the surrounding space in direct lines in the same way that rays are emitted from a source of light. Heat, lost by radiation, does not appreciably warm the air through which the ray passes, but its effects are manifest at any surface which obstructs the passage of the ray.

The surface of the earth is continually losing heat by radiation into space, but during the day it usually receives heat from the sun more rapidly than it loses it by radiation, and consequently it grows warmer. At night, however, heat from this source is cut off and the continued radiation causes the temperature to fall.

Under favorable conditions this fall continues until condensation of vapor begins. Aqueous vapor, although invisible, is always present in greater or less quantities in our atmosphere, and can always be condensed into water if the temperature be sufficiently lowered. If the condensation takes place at temperatures below the freezing point of water, the moisture is deposited in the form of frost.

The heat given off by the condensation of vapor is enormous. The condensation of enough vapor to make a pint of water will evolve enough heat

to raise more than five pints of water from the freezing to the boiling point. All this heat must be lost by radiation in order that the formation of dew may proceed or the temperature fall. It is, therefore, evident that when condensation begins, the heat evolved by this means practically prevents further cooling.

The temperature at which condensation begins is called the "dewpoint," and varies with the amount of moisture in the air, being higher the greater the amount of moisture present. It is always constant for the same amount of vapor.

Radiation takes place most rapidly when there is nothing to obscure the sky. Clouds or any other obstruction act as a screen in retarding it. Even water vapor, while invisable, has a very appreciable effect in retarding it. It takes place more rapidly from the surface of plants than it does from the air about them, so that on still nights these surfaces are frequently cooled several degrees below the temperature of the surrounding air.

One more principle should be considered in the study of conditions under which frost forms, and that is the increased density of the air as its temperature is lowered. Owing to this principle, the air, on calm nights, arranges itself in accordance with its density. The heavier cold air rests on the surface and surrounds the plants and trees, thus increasing their liability to injury. On still nights this fact is often very manifest. Frequently a thermometer close to the ground will read 5° or 10° lower than one eight or ten feet higher. This principle causes the air on slopes, as it becomes chilled by radiation, to flow down into the valleys, where it accumulates, thus frequently causing severe frosts in the lowlands, while the hillsides remain uninjured. It is for this reason that frost does not so readily occur on windy nights, since the wind mixes the air to a more uniform temperature throughout and causes that near the ground to be warmer than it would be otherwise.

Therefore, the conditions favorable to frost formation are: (1) Clear sky, because radiation of heat is rapid under these conditions; (2) dry air, because with dry air, cooling by radiation will continue to a lower temperature before it is checked by the heat given off by condensation; (3) still nights, because under these circumstances the air arranges itself in layers according to its density, and the colder, denser air collects near the surface.

### METHODS OF FROST PREVENTION.

From a study of the foregoing principles under which frost forms, it would seem that there would be the greatest probability of success in preventing frost or diminishing its severity by working along the following lines:

First—Diminishing the radiation of heat.

Second—Raising the dewpoint by adding moisture to the air, and thus making sensible the latent heat of condensation at a temperature above the danger point.

Third—Adding heat to the air.

Fourth—Draining the cold air away from the section which needs protection.

Fifth—Mixing the air so as to prevent the cold air from sinking to the surface.

It is believed that all efficient methods of protection which have been devised are embraced under one or more of these classes. The methods will be grouped in accordance with the above classification.

### METHOD FOR RETARDING RADIATION.

Since radiant heat is transmitted in straight lines, the erection of any screen between the plants and the open sky tends to intercept the rays and either reflect them back toward the earth or absorb them, thus raising the temperature of the screen which checks the loss of heat, for the screen itself now becomes a radiating surface and returns a portion of its heat to the earth. Any substance which tends to obstruct the passage of heat rays forms a more or less effective screen for checking radiation.

*Glass screens*—In greenhouses and hotbeds advantage is taken of the peculiar property of glass, which allows the heat rays of the sun to pass through it, and is almost impervious to the dark heat rays from the earth and plants. This is one of the most perfect screens possible, since it not only prevents the loss of heat by radiation, but receives and retains the heat from the sun. The expense precludes its adoption, except for the protection of valuable plants and flowers.

Screens of other solid materials have been quite extensively used in protecting vineyards and citrus groves where intense cultivation is practiced, and where the location of the groves, near an excellent market, admits of profit even with expensive methods of cultivation.

*Cloth screens*—In Italy and portions of France, screens made of muslin strung on wires stretched on poles above the tops of trees or vines have been used extensively. These screens are drawn on nights when frosts are probable, and pushed back during the day. When the season has advanced so as to preclude further danger, they are taken down and stored. Of course, such a plan could be operated only on a very limited scale, and would then be expensive. This plan has been recently successfully tried in the orange groves of Southern California.

*Lath screens*—During the past few years screens made of laths fastened to ordinary telephone wire (the spaces between them being about the width of the laths) have been extensively used in Florida. These are spread over a frame erected above the trees or plants. The screens serve not only as a fair protection from frost, but also as a shade from hot sun. When no longer needed, they can be rolled up and stored away for preservation. At first thought it would seem improbable that a screen covering only half the space (the spaces being as wide as the laths) would afford much protection; but, when it is considered that laths have considerable thickness, it is plain that, while only one-half the vertical rays are screened, those inclined between the vertical and horizontal are partially intercepted by the edges as well as the faces of the laths. As a matter of fact, about three-fourths of the sky is screened by this means.

By placing the laths in north and south directions, the direct rays of the morning sun are completely cut off from the orchard, which admits of the

temperature rising slowly. This greatly reduces the liability of injury to the plants. Dr. B. T. Galloway, in the United States Department of Agriculture Yearbook, 1895 (p. 145), thus explains why frozen plants are less likely to be injured when warmed slowly:

"Under the influence of cold, the water in the cells escapes, and may be frozen either in the spaces between the cells or on the surface of the leaf, stem, or whatever the part may be. As the temperature rises, this frozen water may again be taken up by the cells, and in such cases little or no injury results. If for any reason, however, the cells are not able to regain the water withdrawn by the cold, injury or even death may result. In many cases the rapidity with which the ice is thawed has a marked effect on the ability of the cells to gain their normal condition. If the thaw is gradual, the water is furnished no faster than the cells can absorb it, and equilibrium is, therefore, soon restored, the chemical processes which were checked during the freeze are resumed, and the plant soon regains its normal condition. With a rapid thaw, however, the cells are not able to take up the water as fast as it is furnished, and as a result chemical decomposition sets in, and death follows. Death in this case is essentially the same as that which results from drought. The cell loses water to such an extent that it is not again able to become turgid, and as a result it finally withers and dies."

*Other methods* While the foregoing methods are quite efficacious in preventing injury, still the expense is entirely too great to admit of their adoption for general use in orchards.

Strawberries and other low plants are frequently protected by covering them with straw or other loose substances.

Frequently young potato plants are saved by plowing a furrow alongside and allowing the dirt to bury them.

Cranberry growers in the marshes of Wisconsin flood the marshes when frost is expected. In this case the protection is probably due, for the most part, to the high specific heat of water, as only portions of this land are submerged.

*Smudge fires*—Since radiation is so reduced as to prevent the formation of frost on cloudy nights, many have thought that an artificial obscuration of the sky by means of dense smoke would be an excellent means of protection. The efforts of this character which have been made have resulted in decidedly varying success. In the wheat fields of the Dakotas excellent protection was obtained, while the experience of orchardists in Florida and Southern California has not shown such a uniform success.

Since it was supposed that the protection resulted from the obscuration of the sky by means of smoke, the best protection was expected from the use of that fuel which would produce the greatest smoke.

In the Dakotas the best and most convenient material at hand was the straw of the previous year's crop, which had been left in the fields all the winter and through the rainy spring, until it was quite thoroughly soaked with water.

In Southern California and Florida straw was scarce, and where it could be obtained it was much drier than that used in the Dakotas, consequently tar, crude petroleum, and other similar smudge materials were substituted :

but the results have not been, as a rule, satisfactory, although the smoke was equally dense. However, quite successful results were obtained by Mr. Buck, Mr. La Rue, and others in the Vacaville and Sonoma sections by burning damp stable manure in sacks scattered through the orchard.

After considering the question, the writer was convinced that the protection of the northern wheat fields must be due to something besides the checking of radiation by the cloud of smoke, for the heat which is radiated from the earth to the cloud is absorbed by the cloud and not reflected. Consequently, unless the air is almost perfectly calm to a considerable elevation, the heat is carried away as the smoke drifts off with the wind before much is radiated by the cloud of smoke back to the earth.

*Damp smudge fuel preferable*—It was observed that, as a rule, whenever damp fuel was used, the efforts at protecting were more successful than at other times. In the case of dry smudge material, the heat of the fire raises the temperature of the air about the burning fuel to hundreds of degrees above the surrounding air. It is consequently greatly expanded, and its density diminished so that it rapidly rises and the neighboring air flows in to take its place. This also is, in turn, heated and escapes upward, carrying the heat and smoke of the fire with it. On reaching an elevation considerably above the trees, it is blown away more or less rapidly by the almost constant circulation of air at such an elevation.

When damp fuel is used, a considerable portion of the heat of the fire is expended in evaporating the water in the fuel, and the consequent upward draft of the fire is lessened by this amount.

The amount of heat consumed in evaporating water is very considerable. The evaporation of a quart of water would necessitate the expenditure of as much energy as would be needed in raising the temperature of the air 25° throughout a space ten feet square and deep.

It is evident from this fact that the upward draft, which was so marked in the case of dry fuel, is greatly diminished when damp fuel is used; consequently, the smoke remains nearer the surface, where the trees interfere with the movement of the wind and tend to retain the smoke, thus increasing the protection.

Further, Tyndall has proven that vapor itself, even while invisible, acts as a barrier in retarding radiation, and if it condenses rapidly enough it will cause the small particles of water thus left suspended in the air to form a cloud or fog, which will obscure the sky and prevent radiation.

However, by far the principal cause of the protection obtained from the wet smudge properly belongs to the second class of methods, namely:

### RAISING THE DEW-POINT.

*By adding moisture to the air and thus making sensible the latent heat of condensation at a temperature above the danger point*—As mentioned above, when damp fuel is used a considerable portion of the heat produced by the fire is expended in evaporating the water in the fuel. The vapor thus formed is invisible and has all the properties of gas, and quickly distributes itself throughout the surrounding space almost as rapidly as air will expand to fill

a vacuum, for it is a property of gases that each will occupy a given space in almost the same manner as it would if the others were not present. But as the vapor expands into the surrounding cooler air its temperature is lowered, and, unless the air be very dry, a portion of the vapor is condensed, forming a visible fog or mist. Now, all the heat which was consumed in evaporating the water again becomes sensible upon its condensation, and tends to raise the temperature of the surrounding air. The heat thus set free will be in great part confined to the particles of water composing the fog, which are too dense to rise, and thus they will tend to prevent the escape of the heat, and at the same time they are so small that they float in the air as fog, with hardly a perceptible tendency to fall.

The tendency is, therefore, to trap the heat produced by the fire and distribute it throughout the space near the surface which needs protection. The excessive heat about the fire, which, with dry fuel, produces the wasteful upward draft, is, in this instance, utilized in evaporating the water in the fuel. The vapor then, by the operation of its gaseous property, distributes itself quickly throughout the surrounding cooler space, where, in condensing, it sets free its latent heat, warming the region, and, by the density of the fine particles of water thus warmed, the heat is retained near the surface.

After a considerable study of various methods of protecting orchards against frost which have thus far been made public, the writer has become convinced that those which depend for their success upon this principle are generally the most efficient. In very dry climates, however, where the dew-point at times of danger is 10° or more below the temperature of the air this method is inefficient since the vapor does not condense in sufficient quantities to protect, and, owing to the vapor being lighter than air, it escapes upward and the heat necessary for its formation is lost.

Many methods which involve this principle have been suggested and tried, two of which have already been mentioned, namely:

*Fires of damp straw and stable manure.*—Have the fuel, in small piles, distributed throughout the orchard in advance: the more numerous the piles the better. With the same amount of fuel the best protection is obtained from small and frequent fires, since, with small fires, the upward draft is reduced to a minimum, and the more frequent the fires the more uniform will be the distribution of heat.

*Sacks of manure.*—A decidedly preferable method is to pack damp stable manure in common grain or burlap sacks, by which it can be conveniently handled. They should be distributed through the orchards in rows about one hundred feet apart, and about fifty feet between sacks in each row. When it is found necessary to protect, a small amount of coal oil is poured upon each sack and ignited. It is usually unnecessary to fire more than every second or fourth sack, the remainder being left for later occasions. These sacks will burn with a smoldering fire for several hours.

The amount of heat which is set free by burning one sack of manure weighing about fifty pounds, and condensing the vapor near the surface, would be sufficient to raise the temperature 20° in a space of seventy-five feet square and twenty-five feet deep. If one-fourth of this heat remained

within the region needing protection, which seems to be a reasonable estimate, ample protection would be obtained for almost any ordinary conditions.

*Bales of wet straw*—Mr. T. A. Morrison of Riverside, California, suggested the use of a similar plan, in which bales of wet straw were substituted for manure. This plan has been tried with fair success. One hundred pound bales were cut in four pieces, a tie-wire being left about each piece, and, if properly dampened, will burn with but little care, causing a small smouldering fire.

*Prunings*—The prunings of the trees, which are usually removed shortly before the period when frosts are likely to do their greatest injury, are excellent smudge material, and should always be preserved for this use. They should be piled in open spaces throughout the orchard or vineyard, and burned at times when protection may be needed. The best results will be obtained from as small fires as will result in burning the prunings.

### PORTABLE SMUDGE FIRES.

A number of excellent devices have been tried, in which the fires were built upon some vehicle by which they could be moved about the orchard. The advantages of this plan are several:

First—The fire can be moved to the section where most needed, generally along the windward side of the orchard.

Second—The loss of heat by an upward draft is almost entirely prevented, since the fire does not remain in one position long enough to establish such a draft. On this account much larger and, consequently, fewer fires, with equal efficiency, are possible.

Third—There is much more uniform distribution of heat throughout the orchard.

*The Fleming Fruit Company's process*—One of the first to adopt this plan was the Fleming Fruit Company of Visalia, California, the manager of which thus describes his method:

"We built wire frames (chicken-yard fencing) on our low truck wagons, stretching them from four wagon stakes and heaping over with wet manure. Dirt was then thrown on the wagon beds to protect them, and pots of burning tar were set underneath the straw roof. A barrel of water on the wagon was used to keep the straw wet. These wagons were driven about and did the best work, as they could go wherever most needed. The smoke and vapor were carried to the rear as the wagon moved, and, being carried at once out of the rising heat, fell close to the ground in a long, white trail. At daylight our whole four hundred acres of orchard were covered with a white fog, extending from the ground to about twenty feet high."

They also used similar fires as stationary smudges, the wire netting being stretched between four stakes driven in the ground, and a similar plan has been since experimented with by Meacham Brothers of Riverside, California. These latter proved much less efficient.

*The plan of the Rio Benito Orchard Company*—A modified form of the Fleming process was used with excellent results by this company at Biggs, California. In this case rough sleds were constructed at a cost of less than $2 each. The runners were of 2x4 scantling, which were connected by a

few boards about four feet long. Upon these dirt was piled to hold the pot of burning tar. The four upright sticks were spiked to the runners, the tops of which, about eighteen inches above the bed of the sled, were connected by strips of inch boards four to six inches wide. To these strips the chicken-wire netting was attached. This rude box or screen supported the wet straw or manure used as smudge material. Four of these sleds, two wagons rigged after the Fleming plan, and about five hundred sacks of manure were found sufficient protection for an orchard of three hundred acres during each night of the severe April frost of 1896. The orchard was successfully protected during six successive nights of severe frost, at an expense of less than one per cent. of the value of the crop undoubtedly saved by this means.

This device can be made much more efficient by supporting the center of the screen by an arch of heavy, stiff wire passing diagonally from runner to runner and forcing up the bottom of the screen so as to cause it to present a concave surface to the fire, thus causing more of the heat to pass through the smudge material and less to escape upward about the sides of the screen.

DIRECTLY HEATING THE AIR BY MEANS OF FIRES.

*Mr. Edward Copley's plan.*—Mr. Edward Copely, of Riverside, California, in several articles published in the *Riverside Press*, of April, 1896, describes at length experiments which he has made in heating the air directly by small fires of coal, placed in wire buckets hung a short distance above the ground. In his discussion, he takes into consideration the fact that on frosty nights the air for some distance above the ground is considerably warmer than the surface, consequently it would be possible to warm the lower air until its temperature and resulting density were equal to those of the air above the surface before there would be any tendency of the surface air to rise and escape. Therefore, he believes that it is possible, by means of small fires to warm the lower stratum of air sufficiently to prevent frost, and, at the same time, avoid loss of heat, which would result were there an upward draft of sufficient force to carry the heated air above the tree tops.

The difficulties experienced in all methods of directly heating the air arise from the unequal distribution of the heat through the lower portion of the air, on account of which the warmer masses of air rise above the region needing protection, and cold, denser air is continually flowing in from the sides to replace them. Of course, this upward draft will be less with small than with large fires.

During the winter of 1897–98 a number of unusually severe frosts occurred in the citrus region of California. Advantage was taken of these occasions by the Horticultural Club of Riverside to test many devices. Below is given an account of these experiments, which were probably the most extensive and carefully conducted of any ever made in this country. These show very conclusively the value of these small fires in protection in such a dry climate as exists at Riverside. In fact this method proves most satisfactory of all those tested, and a similar result will probably be found to be the case in places where the dew-point is 10° or more below the temperature of the

air at times of danger. From what the writer is able to learn he does not think the trials of the damp smudge were generally made in the most efficient manner; however, in very dry climates, the vapor of the wet smudge diffuses throughout the surrounding space without condensing, thus rendering that method of protecting inefficient.

### MIXING THE AIR SO AS TO PREVENT THE COLD AIR FROM SINKING TO THE SURFACE.

While many of the preceding methods depend partly on this principle for their success, the writer is not familar with any process which depends solely upon it.

### WHEN AND HOW TO PROTECT.

The experience of the past two seasons has shown that forecasts of sudden and decided changes in temperature over a large territory are among the most accurate made by the Weather Bureau: consequently, it is reasonable to expect that, if suitable arrangements are made, warnings may be received of those otherwise unexpected cool waves, which will result in frost. There are instances, however, when the general forecasts of the Weather Bureau cannot be expected to be sufficiently specific to provide for the different conditions that may prevail in various sections. The temperature frequently remains for several days near the critical point, and a change of a very few degrees or a local clearing or clouding of the sky will cause or prevent injury. Again, the conditions in certain localities are such as to make them more susceptible to frost than the surrounding region. Prof. Willis L. Moore, Chief of the Weather Bureau, states that, while forecast official in Wisconsin, he observed that a frost occurring immediately after a rain was not as injurious as when the ground and plants were dry. It is therefore necessary that the orchardist and gardener be able to judge, at times, for themselves when frost is imminent. For this purpose they should be provided with a wet and dry-bulb hygrometer, by which can be determined the dew-point of the air or the temperature at which condensation takes place. Condensation checks the fall in temperature on frosty nights. Frequent observations with this instrument should be made.

If, in the afternoon, the dew-point is near the critical temperature, arrangements should be made for protecting, if necessary. If, at a later hour, the dew-point is constant or lower, the sky clear or clearing, and the air calm, it is reasonable to expect that the temperature will fall to the dew-point during the night. The efforts to protect should be based on this dew-point. If it merely approximates the danger point (and no warning of more severe temperatures has been received) but little protection will be necessary, and action may be delayed until the temperature is but a few degrees above the danger point. However, if the dew-point be several degrees below that liable to cause injury, or if it be falling, or if a change for the colder be anticipated, efforts to protect should be undertaken earlier.

No specific rules of universal application can be laid down for the guidance of the orchardist in protecting. The same intelligent, careful, and sys-

tematic attention must be given to this as to other subjects, in order to secure success. However, the following suggestions may be of value:

Irrigation should be resorted to wherever possible. The water should be turned on during the day preceding the night when frost is anticipated, and continued until the ground is thoroughly saturated.

In all sections it is recommended that either coal baskets or some method for causing a wet smudge be used, or a combination of both. The coal baskets will be found the more useful the drier the air and the greater the excess in temperature thirty or forty feet from the ground, and near the surface, as previously explained. For the purpose of determining this difference a pole forty or fifty feet long, with halyards, like a flagstaff, should be erected in the orchard. Two thermometers should be attached to the halyards, so that as one thermometer is at the top of the pole the other is five feet from the surface. Leave one thermometer at the top of the pole for five minutes; read the one near the ground, and then quickly lower and read the one which has been at the top of the pole.

When coal baskets are used there should be from twenty-five to fifty of them used to the acre, depending on the intensity of cold, as described in the reports of the Horticultural Club of Riverside. When the wet smudge is used probably better results would be obtained from a combination of the portable and stationary smudges. About one wagon or sled, arranged for carrying an evaporating fire, should be provided for each fifty acres. In addition, stationary smudges should be used. The material for these should be prepared at the beginning of the frost season, and kept in readiness for immediate use. Sacks filled with wet manure or bales of wet straw should be distributed throughout the orchard. The sacks should be placed about seventy-five feet apart each way, at the intersection of the rows. A smaller number of bales of straw is necessary. Hollows should be dug a few inches deep about each sack, and, if the sack becomes dry before being used, a pailful of water should be poured upon it, which will remain in the hollow near the sack until absorbed. Whenever it is necessary to protect, an effort should be made to determine the direction in which the air drifts across the orchard. And the sacks should be fired in rows running across this draft, beginning at the windward side of the orchard. Every sack should be ignited in the row, but only every third or fourth row need be burned the first night: the remainder being available for succeeding nights. In setting fire to the sacks, one man goes ahead with a pail of coal oil and pours about a pint on each sack; and another, following with a torch, ignites them. In the meantime, portable smudges should be put in operation. They should be driven forward and back between the rows and across the drafts of the orchard. It is very desirable, if not essential, that the superintendent take a position on the most elevated point at his command, as the top of a house, barn, water tank, or windmill, from which he can observe the drift of the smudge and direct the movement of the teams so as to secure the best results.

It would seem that these precautions should be sufficient to prevent injury, unless it be in the case of narrow valleys, where the cold air from the unpro-

tected hillsides displaces that which has been kept warm, and, should windbreaks be found successful in removing this danger, it is believed there are few, if any, localities where injury could not be avoided.

It is evident that in attempting to protect one ranch the owner will, in a measure, protect his neighbor; therefore, if some arrangements for co-operation among the individuals in the same locality were made, the greatest protection could be provided at the minimum expense. By such a co-operation of all the residents of the valley, a system of windbreaks or air-drainage dikes (if found valuable) could be laid out and built in such a manner as to result in the greatest general good at the least cost. Arrangements could be made which would insure the distribution of a frost warning from the Weather Bureau throughout the entire district. Some person, provided with a telephone, could receive the warnings from the bureau, and, in turn, telephone them to all others having such instruments. All so receiving them could display the frost signal, and thus the warning would be quite generally distributed.

Some person in each locality or ranch should study the peculiarities of his section. He should thoroughly understand the conditions under which frost forms, should provide himself with a psychrometer, and take frequent observations on afternoons and evenings when frost is imminent, and thus be enabled to give the most accurate information possible to his locality. He would probably thus prevent the inconvenience and expense connected with protecting when the local conditions or a change in the weather were such as would prevent a frost, and also he would be likely to discover times when frost was imminent when no warning had been received. This man, indeed, should be a sort of local expert on this subject.

### THE USE OF THE SLING PSYCHROMETER.

This instrument is a form of hygrometer most suitable for the use of the orchardist. It consists of two thermometers fastened to the same back and arranged for whirling. One of the thermometers has its bulb covered with thin muslin, moistened with water. The evaporation of the water about the wet bulb lowers the temperature and causes this thermometer to read lower than the one with a dry bulb. From the difference between these readings and the temperature of the air itself the dew-point can be quite accurately determined from the accompanying table.

*Exposure*—While the psychrometer will give quite accurate indications, even in the bright sunshine, yet observations so made are not without some error, and where greater accuracy is desired the psychrometer should be whirled in the shade of a building or tree, or, as may sometimes be necessary, under an umbrella. In all cases there should be perfectly free circulation of the air, and the observer should face the wind, whirling the psychrometer in front of his body. It is a good plan, while whirling, to step back and forth a few steps, to further prevent the presence of the observer's body from giving rise to erroneous observations.

*The wet bulb*—It is important that the muslin covering for the wet bulb be kept in good condition. The evaporation of the water from the muslin leaves

always in its meshes a small quantity of solid material, which, sooner or later, somewhat stiffens the muslin, so that it does not readily take up water. This will be the case if the muslin does not readily become wet after being dipped in water. On this account it is desirable to use as pure water as possible, and also to renew the muslin from time to time. New muslin should always be washed to remove the sizing, etc., before used. A small rectangular piece, wide enough to go about one and one-third times around the bulb and long enough to cover the bulb and that part of the stem below the metal back, is cut out, thoroughly wetted in clean water, and neatly fitted around the thermometer. It is tied first around the bulb at the top, using a moderately strong thread. A loop of thread to form a knot is next placed around the bottom of the bulb, just where it begins to round off. As this knot is drawn tighter and tighter the thread slips off the rounded end of the bulb and neatly stretches the muslin covering with it, at the same time securing the latter at the bottom.

*To make an observation.* The so-called wet bulb is thoroughly saturated with water by dipping it into a small cup or wide-mouthed bottle. The thermometers are then whirled rapidly for fifteen or twenty seconds, stopped and quickly read. A mental note of the readings is made, when they are again whirled and read. This will be continued until the wet-bulb thermometer ceases to fall, when the readings of the two thermometers should be read and recorded. If the wet thermometer should read 32°, the whirlings and frequent readings should be continued for a considerable time, to be certain that a further fall will not take place. The freezing of the water at 32° causes the fall to be checked for a short time.

Subtract the reading of the wet thermometer from that of the dry. Find this difference in the line at the top of the table. The dew-point will be found at the intersection of the column beneath with the line which has the proper dry thermometer reading at the left.

FIRST EXAMPLE.

| | |
|---|---|
| Dry-bulb thermometer | 55° |
| Wet-bulb thermometer | 44 |
| Difference | 11 |
| Dew-point from table | 30 |

SECOND EXAMPLE.

| | |
|---|---|
| Dry-bulb thermometer | 43° |
| Wet-bulb thermometer | 38 |
| Difference | 5 |
| Dew-point from table | 31 |

## DEW-POINT TABLE—FAHRENHEIT TEMPERATURES.

| $t$ (Dry ther.) | Difference between the dry and wet thermometers ($t$—$t'$). | | | | | | | | | | | | | | | | | | | | $t$. (Dry ther.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | |
| 20 | 17 | 13 | 8 | 2 | —6 | —19 | | | | | | | | | | | | | | | 20 |
| 21 | 18 | 14 | 9 | 4 | —4 | —15 | —47 | | | | | | | | | | | | | | 21 |
| 22 | 19 | 15 | 11 | 6 | —1 | —11 | —31 | | | | | | | | | | | | | | 22 |
| 23 | 20 | 16 | 12 | 7 | +1 | —8 | —24 | | | | | | | | | | | | | | 23 |
| 24 | 21 | 18 | 14 | 9 | 3 | —5 | —18 | | | | | | | | | | | | | | 24 |
| 25 | 22 | 19 | 15 | 11 | 5 | —2 | —13 | —42 | | | | | | | | | | | | | 25 |
| 26 | 23 | 20 | 16 | 12 | 7 | 0 | —9 | —28 | | | | | | | | | | | | | 26 |
| 27 | 24 | 21 | 18 | 14 | 9 | +3 | —6 | —20 | | | | | | | | | | | | | 27 |
| 28 | 25 | 22 | 19 | 15 | 11 | 5 | —3 | —15 | —54 | | | | | | | | | | | | 28 |
| 29 | 26 | 24 | 20 | 17 | 12 | 7 | 0 | —10 | —32 | | | | | | | | | | | | 29 |
| 30 | 27 | 25 | 22 | 18 | 14 | 9 | +2 | —6 | —22 | | | | | | | | | | | | 30 |
| 31 | 29 | 26 | 23 | 19 | 15 | 11 | 5 | —3 | —15 | | | | | | | | | | | | 31 |
| 32 | 30 | 27 | 24 | 21 | 17 | 13 | 7 | 0 | —10 | —33 | | | | | | | | | | | 32 |
| 33 | 31 | 28 | 25 | 22 | 18 | 14 | 9 | +3 | —6 | —22 | | | | | | | | | | | 33 |
| 34 | 32 | 29 | 26 | 24 | 20 | 16 | 11 | 6 | —2 | —15 | | | | | | | | | | | 34 |
| 35 | 32 | 30 | 28 | 25 | 22 | 18 | 13 | 8 | +1 | —9 | —32 | | | | | | | | | | 35 |
| 36 | 34 | 31 | 29 | 26 | 23 | 19 | 15 | 10 | 4 | —5 | —20 | | | | | | | | | | 36 |
| 37 | 35 | 32 | 30 | 27 | 24 | 21 | 17 | 12 | 6 | —2 | —14 | —52 | | | | | | | | | 37 |
| 38 | 36 | 33 | 31 | 28 | 26 | 22 | 19 | 14 | 9 | +2 | —8 | —29 | | | | | | | | | 38 |
| 39 | 37 | 34 | 32 | 29 | 27 | 24 | 20 | 16 | 11 | 5 | —4 | —18 | | | | | | | | | 39 |
| 40 | 38 | 35 | 33 | 30 | 28 | 25 | 22 | 18 | 13 | 8 | 0 | —12 | —41 | | | | | | | | 40 |
| 41 | 39 | 36 | 34 | 32 | 29 | 26 | 23 | 20 | 15 | 10 | +4 | —6 | —25 | | | | | | | | 41 |
| 42 | 40 | 38 | 35 | 33 | 30 | 27 | 24 | 21 | 18 | 12 | 7 | —2 | —15 | | | | | | | | 42 |
| 43 | 41 | 39 | 36 | 34 | 31 | 29 | 26 | 23 | 19 | 14 | 9 | +2 | —8 | —33 | | | | | | | 43 |
| 44 | 42 | 40 | 37 | 35 | 32 | 30 | 27 | 24 | 20 | 16 | 12 | 6 | —4 | —19 | | | | | | | 44 |
| 45 | 43 | 41 | 39 | 36 | 33 | 31 | 28 | 25 | 22 | 18 | 13 | 8 | 0 | —11 | —48 | | | | | | 45 |
| 46 | 44 | 42 | 40 | 37 | 35 | 32 | 30 | 27 | 24 | 20 | 16 | 11 | +4 | —5 | —24 | | | | | | 46 |
| 47 | 45 | 43 | 41 | 39 | 36 | 33 | 31 | 28 | 25 | 22 | 18 | 13 | 7 | —1 | —14 | | | | | | 47 |
| 48 | 46 | 44 | 42 | 40 | 37 | 35 | 32 | 29 | 26 | 23 | 20 | 15 | 10 | +2 | —8 | —30 | | | | | 48 |
| 49 | 47 | 45 | 43 | 41 | 38 | 36 | 33 | 31 | 28 | 25 | 21 | 17 | 12 | 6 | —3 | —18 | | | | | 49 |
| 50 | 48 | 46 | 44 | 42 | 40 | 37 | 34 | 32 | 29 | 26 | 23 | 19 | 14 | 9 | +1 | —10 | —42 | | | | 50 |
| 51 | 49 | 47 | 45 | 43 | 41 | 38 | 36 | 33 | 31 | 28 | 24 | 21 | 17 | 11 | 5 | —5 | —22 | | | | 51 |
| 52 | 50 | 48 | 46 | 44 | 42 | 40 | 37 | 34 | 32 | 29 | 26 | 23 | 19 | 14 | 8 | 0 | —13 | | | | 52 |
| 53 | 51 | 49 | 47 | 45 | 43 | 41 | 38 | 36 | 33 | 30 | 28 | 24 | 20 | 16 | 11 | +4 | —6 | —28 | | | 53 |
| 54 | 52 | 50 | 49 | 46 | 44 | 42 | 40 | 37 | 34 | 32 | 29 | 26 | 22 | 18 | 13 | 7 | —2 | —16 | | | 54 |
| 55 | 53 | 52 | 50 | 48 | 46 | 43 | 41 | 39 | 36 | 33 | 30 | 28 | 24 | 20 | 16 | 10 | +3 | —8 | | | 55 |
| 56 | 54 | 53 | 51 | 49 | 47 | 44 | 42 | 40 | 37 | 34 | 32 | 29 | 26 | 22 | 18 | 13 | 6 | —2 | —19 | | 56 |
| 57 | 55 | 54 | 52 | 50 | 48 | 46 | 44 | 41 | 39 | 36 | 33 | 30 | 28 | 24 | 20 | 15 | 10 | +2 | —10 | —48 | 57 |
| 58 | 56 | 55 | 53 | 51 | 49 | 47 | 45 | 42 | 40 | 37 | 35 | 32 | 29 | 26 | 22 | 18 | 12 | 6 | —3 | —22 | 58 |
| 59 | 57 | 56 | 54 | 52 | 50 | 48 | 46 | 44 | 41 | 39 | 36 | 33 | 31 | 27 | 24 | 20 | 15 | 9 | +1 | —12 | 59 |
| 60 | 58 | 57 | 55 | 53 | 51 | 49 | 47 | 45 | 43 | 40 | 38 | 35 | 32 | 29 | 26 | 22 | 18 | 12 | 5 | —5 | 60 |
| 61 | 59 | 58 | 56 | 54 | 52 | 50 | 48 | 46 | 44 | 42 | 39 | 36 | 33 | 31 | 28 | 24 | 20 | 15 | 9 | 0 | 61 |
| 62 | 60 | 59 | 57 | 55 | 53 | 52 | 50 | 48 | 45 | 43 | 41 | 38 | 35 | 32 | 29 | 26 | 22 | 18 | 12 | +5 | 62 |
| 63 | 61 | 60 | 58 | 56 | 55 | 53 | 51 | 49 | 47 | 44 | 42 | 39 | 37 | 34 | 31 | 28 | 24 | 20 | 15 | 9 | 63 |
| 64 | 62 | 61 | 59 | 57 | 56 | 54 | 52 | 50 | 48 | 46 | 43 | 41 | 38 | 35 | 32 | 29 | 26 | 22 | 18 | 12 | 64 |
| 65 | 63 | 62 | 60 | 59 | 57 | 55 | 53 | 51 | 49 | 47 | 45 | 42 | 40 | 37 | 34 | 31 | 28 | 24 | 20 | 15 | 65 |
| 66 | 64 | 63 | 61 | 60 | 58 | 56 | 54 | 52 | 50 | 48 | 46 | 44 | 41 | 38 | 35 | 32 | 30 | 26 | 22 | 18 | 66 |
| 67 | 66 | 64 | 62 | 61 | 59 | 57 | 55 | 54 | 52 | 50 | 47 | 45 | 43 | 40 | 37 | 34 | 31 | 28 | 24 | 20 | 67 |
| 68 | 67 | 65 | 63 | 62 | 60 | 58 | 57 | 55 | 53 | 51 | 49 | 46 | 44 | 42 | 39 | 36 | 33 | 30 | 26 | 23 | 68 |
| 69 | 68 | 66 | 64 | 63 | 61 | 59 | 58 | 56 | 54 | 52 | 50 | 48 | 46 | 43 | 40 | 38 | 34 | 32 | 28 | 25 | 69 |
| 70 | 69 | 67 | 66 | 64 | 62 | 61 | 59 | 57 | 55 | 53 | 51 | 49 | 47 | 45 | 42 | 39 | 36 | 33 | 30 | 27 | 70 |
| 71 | 70 | 68 | 67 | 65 | 63 | 62 | 60 | 58 | 56 | 55 | 53 | 51 | 48 | 46 | 43 | 41 | 38 | 35 | 32 | 29 | 71 |
| 72 | 71 | 69 | 68 | 66 | 64 | 63 | 61 | 59 | 58 | 56 | 54 | 52 | 50 | 47 | 45 | 43 | 40 | 37 | 33 | 31 | 72 |
| 73 | 72 | 70 | 69 | 67 | 66 | 64 | 62 | 61 | 59 | 57 | 55 | 53 | 51 | 49 | 46 | 44 | 41 | 38 | 35 | 32 | 73 |
| 74 | 73 | 71 | 70 | 68 | 67 | 65 | 63 | 62 | 60 | 58 | 56 | 54 | 52 | 50 | 48 | 45 | 43 | 40 | 37 | 34 | 74 |
| 75 | 74 | 72 | 71 | 69 | 68 | 66 | 64 | 63 | 61 | 59 | 57 | 56 | 54 | 52 | 49 | 47 | 44 | 42 | 39 | 36 | 75 |
| 76 | 75 | 73 | 72 | 70 | 69 | 67 | 65 | 64 | 62 | 61 | 59 | 57 | 55 | 53 | 50 | 48 | 46 | 43 | 41 | 38 | 76 |
| 77 | 76 | 74 | 73 | 71 | 70 | 68 | 67 | 65 | 63 | 62 | 60 | 58 | 56 | 54 | 52 | 50 | 48 | 45 | 42 | 40 | 77 |
| 78 | 77 | 75 | 74 | 72 | 71 | 69 | 68 | 66 | 65 | 63 | 61 | 59 | 57 | 55 | 53 | 51 | 49 | 47 | 44 | 41 | 78 |
| 79 | 78 | 76 | 75 | 73 | 72 | 70 | 69 | 67 | 66 | 64 | 62 | 61 | 59 | 57 | 55 | 53 | 51 | 48 | 46 | 43 | 79 |
| 80 | 79 | 77 | 76 | 74 | 73 | 72 | 70 | 68 | 67 | 65 | 63 | 62 | 60 | 58 | 56 | 54 | 52 | 50 | 47 | 45 | 80 |
| $t$. | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | $t$. |

## INJURIOUS TEMPERATURES.

Table of temperatures at which the following plants are liable to receive injury from frost, compiled from information received from horticulturists, orchardists, and gardeners throughout the entire Pacific Coast.

The temperatures given are, as nearly as possible, those of the air in contact with the plant itself.

| *Plants or Fruits.* | *In Bud.* | *In Blossom.* | *In Setting Fruit.* | *At Other Times.* |
|---|---|---|---|---|
| | ° | ° | ° | ° |
| Almonds | 28 | 30 | 30 | 28 |
| Apples | 27 | 29 | 30 | 26 |
| Apricots | 30 | 31 | 32 | 30 |
| Asparagus | 29 | 29 | 29 | 26 |
| Bananas | 31 | 31 | 32 | 31 |
| Barley | | 29 | | |
| Beans | | 31 | | |
| Beets | | | | 25 |
| Cabbage | | | | 15–27 |
| Cantaloupes | 32 | 32 | | 30–31 |
| Cauliflower | | | | 20–27 |
| Celery | | | | 28 |
| Cucumbers | 31 | 31 | 31 | 32 |
| Cymlings or squash | 31 | 31 | 31 | 30 |
| Flowers* | 31 | 31 | 31 | 30 |
| Grapes | 31 | 31 | 30 | 28 |
| Grape Fruit | 30 | 31 | 31 | 28 |
| Lemons | 30 | 31 | 31 | 28 |
| Lettuce | | | | 12–28 |
| Mandarins | 31 | 31 | 31 | 28 |
| Oats | 31 | | | |
| Okra | | | | 31 |
| Olives | 30 | 31 | 31 | ‡18<br>§24 |
| Onions | | | | 29 |
| Oranges† | 30 | 31 | 31 | ‡26<br>§29 |
| Parsnips | | | | 27 |
| Peaches | 29 | 30 | 30 | 29 |
| Pears | 28 | 29 | 29 | 28 |
| Peas | 29 | 30 | 30 | 25 |
| Plums | 30 | 31 | 31 | 29 |
| Potatoes: | | | | |
| Irish | 30 | 30 | 30 | 31 |
| Sweet | 31 | 31 | 31 | 31 |
| Prunes | 30 | 31 | 31 | 29 |
| Radishes | | | | 25 |
| Shrubs, roses, or trees | 26–30 | 28–32 | | 30–26 |
| Spinach | | | | 21 |
| Strawberries | 28 | 28 | 28 | 30 |
| Tangerines | 31 | 31 | 31 | 28 |
| Tomatoes | 31 | 31 | 31 | 31 |
| Turnips | | | | 26 |
| Watermellons | | | | 28–31 |
| Wheat | | 31 | 31 | |
| Walnuts, English | 30 | 31 | 31 | 28 |

*Depends on variety. †Injured at 2° higher if continued four to six hours. ‡Ripe. §Green

# COMPRESSED AIR FOR SPRAYING.

## EXCELLENT WORK WITH A NEW CONTRIVANCE—ADVANTAGES OF A LOW-DOWN CART.

By A. I. Loop, of Pennsylvania.

Fig. 271 shows the manner of charging the air tanks, while Fig. 272 shows the machine in operation. The rig is perhaps a little expensive, but it does the work fast — just as fast as you wish to — and the hard work is a thing of the past. The entire outfit consists of a two-horsepower gasoline engine and a Clayton No. 6 air compressor mounted on a one-horse wagon, as shown in Fig. 271, and two two-wheeled carts carrying the air and mixture tanks. Each cart is supposed to carry two tanks of fifty to one hundred gallons each. The photo shows three tanks. I had intended to use a small tank for air and have the initial pressure two hundred pounds, but in practice I found it better to have more air space and lower pressure, so I added another tank. The two tanks are connected together by one quarter-inch gas pipe and shut-off valve. Each tank has a steam gauge to show at all times the amount of pressure inside it. One tank has a hose connection with common union coupling to attach it to air compressor. The other tank has a large pipe connection at bottom. This pipe turns up behind the tank and terminates with a large valve — refilling valve. Near the turn of the large pipe is a tee connection having attached two lines of hose, as shown in the picture: of course more lines can be connected if thought best. The energy is stored before commencing work, so the number of nozzles used has no bearing on the quality of the work done.

The carts are very simple affairs, home-made; two thills with three cross pieces, all bolted together, with the tanks strap-bolted to cross pieces. The first picture shows how the engine and air-pump are mounted on a heavy one-horse wagon, so as to be easily moved to any point where it is most convenient to water to fill spray tank. Operation is as follows: One cart is backed up to the compressor, as shown in first picture; the hose is connected (about ten seconds' work) and engine started. The operator then takes a large wooden pail or tub with short piece of pipe in bottom that fits the refilling valve, opens a little relief valve at top of spray tank, and pours the mixture in. By the time the operator gets the mixture tank full, the engine has got up a pressure of one hundred and twenty-five pounds in the air tank and is ready to begin operations. The machine is now ready for use; is disconnected from the compressor and driven to orchard. When ready to throw spray, the valve in small pipe connecting air to mixture tank is opened a little. In two or three seconds the gauge on mixture tank will show fifty or sixty pounds pressure. This is about the right pressure to throw a dense fog of spray—as long as nozzles are in use the little valve is left open slightly, so that the pressure in the spray tank is constant at fifty to sixty pounds. If the

FIG. 271.—Charging the Air Tanks by Machinery.

FIG. 272.—The Compressed Air Outfit in the Field.

nozzles are shut off for a minute or two longer it is closed, so pressure will not go too high. I use two lines of hose—and sometimes four nozzles on each line. Fig. 272 shows two nozzles: sometimes it is economy to use one nozzle: depends on what is being sprayed.

A dozen nozzles on each hose could be used, and all would do equally good work, but it would bother a man to move around fast enough to use them without wasting mixture. This is a point wherein it is superior to a steam pump. The low cart can be taken with ease under any tree where a horse can go. A horse will draw the cart wherever he can draw a cultivator, up hill or down. When the spray mixture is exhausted, the valve between the tanks is closed (saving sixty pounds or so of pressure in the air tank), the refilling valve opened, and in a few seconds all settlings and waste is blown out. By the time the first tank is sprayed out the second is charged ready for use, so no time is lost, only that used in changing horse from one to the other. No agitator is used. If the mixture is properly prepared, it will not settle enough to cause any damage, as it does not take long to use up fifty gallons or more of mixture—the time depends entirely upon how many nozzles are used, and how quickly the man with the hose can move.

Now as to the cost. For my purpose, all things considered, a gasolene engine seemed to be best. It cost $165, is two-horse power, weighs about two hundred and fifty pounds. The barrel shown in Fig. 271 is half full of water, connected by pipes with water-jacket of engine cylinder. The can up on the frame is the gasolene supply. I heat the hot tube with charcoal: that is the only stuff I have found that will not blow out on a windy day. The air compressor is a 3x6 No. 6 Clayton-Brackett compressor, cost $60. Engine runs four hundred revolutions, size of pulley ten inches, belt three inches. With only one hundred and twenty-five pounds maximum pressure and the fact that in changing, the compressor stops, no water-jacket is really necessary, although I use a little water in the jacket.

The tanks can be had of any manufacturer of soda-water or bottlers' supplies. They are known to the trade as "air tanks." They can be had in any size, are tested to two hundred pounds or more, are not very heavy, and cost, last winter, $15 each for fifty-gallon tanks. Everyone knows what nozzles, hose and connections cost. I used grape-wagon wheels and axle for the carts. The framework costs possibly $5, for each. I used fifty-gallon tanks because I have to use up pretty steep hillsides, and wanted it so one horse would have no trouble.

# THE CODLING MOTH.

*Carpocapsa pomonella*, Linn.

Order LEPIDOPTERA: family GRAPHOLITHIDÆ.

By PROF. M. V. SLINGERLAND.

Almost every lover of fruits has seen a wormy apple, and most people understand that, as our little two-year-old daughter puts it, "a naughty old worm did it." The time is soon coming when these little observers of nature will not be content with this meager information, and fathers and mothers will be called upon to tell more of the story of the life of this "naughty old worm." How few of us know this story!

This apple worm is one of the most serious drawbacks to the profitable growing of apples by the average fruitgrower. From one-fourth to one-half of the apple crop in the United States is usually ruined annually by this insect; it thus exacts millions of dollars of tribute yearly from our fruitgrowers. As many of our more progressive orchardists have already learned, the number of wormy fruits can be largely reduced by the intelligent application of modern methods. In spite of the fact that this insect usually causes a greater monetary loss to the apple grower than all the other insect foes of the apple combined, yet it can be often more easily controlled than the apple borer, the canker worms, and several other orchard pests. We wish that every apple grower could be induced to read, from nature's book if possible, the life-story of this insect, and then put to practical use the knowledge thus obtained. For we are hopeful that then it would not be necessary to look over a bushel of apples in our city markets to find half a dozen that were not wormy: and besides the apple grower would then be prepared to introduce a very interesting bit of nature-study into the home whenever the little ones chanced upon the work of the "naughty old worm." It has come to be a well-established fact in our experience among fruitgrowers, that those who combat their insect foes with the least trouble, the most successfully, and get the most fun out of it—they are the ones who like Hiawatha have:

"Learned their names and all their secrets,
How they built their nests in summer,
Where they hide themselves in winter,
Talked with them when'er he met them."*

*As some inquisitive mind may wonder why it is necessary that man should be tormented with this little worm whose palace is the wormy apple, we submit the only attempt at an explanation that we have seen: "Or were they created, solitary preachers on each little globe of fruit, which falls like manna from above, to teach us some great moral lesson? Come they into our very faces to remind us how 'dearly we pay for the primal fall?' Do they inhabit the finest specimens of that fruit by which our first mother was tempted, in order to bid us taste the viands of Eden, and make us feel that 'the trail of the serpent hangs over them all?'"

123.—Pictures of the codling-moth, showing its variations.
All natural size, except the two large ones,
which are enlarged twice.

Naturally much has been written about an insect of such great economic importance, and yet the literature embraces but comparatively few approximately exhaustive and comprehensive accounts of it: none of these are now easily accessible to the fruitgrower. By far the best account, written by Dr. L. O. Howard, was published in 1888, and no similar attempt has been made by American writers since. Although many reports, comprising thousands of pages of printed matter, have been made on the insects of New York State, it is a surprising fact that everything therein pertaining to this most important of all orchard pests would occupy little more than half a dozen printed pages. We began a critical study of the insect in the spring of 1896, and for nearly two years have devoted much time to careful observations of its habits in all stages. Considerable time has also been spent in ransacking all of the foreign, as well as American, literature that could be bought or borrowed: several interesting facts have been gleaned from this search through many quaint and musty records which make up the history of this insect.

The above facts, we believe, fully warrant the somewhat exhaustive discussion of this pest which follows:

### SOME GENERAL HISTORICAL NOTES.

It is said that Cato speaks of "wormy apples" in his treatise on agriculture, written nearly two hundred years before the Christian era. In the first century A. D., both Columella and Pliny doubtless refer to this insect in their writings. Pliny says: "The fruits themselves, independently of the tree, are very much worm-eaten in some years, the apple, pear, medler, and pomegranate for instance." While the apple growers of these ancient times were doubtless familiar with the work of this worm, yet the real history of the insect itself apparently begins in 1635, or almost with the beginning of purely entomological literature. A translation, with a reproduction of the pictures, of this first quaint Dutch account is given in Fig. 126. Nearly a century seems to have elapsed before we again find the insect discussed by entomologists. In 1728, Frisch, a German writer, gave us the first detailed descriptions of the insect: his grotesque pictures of the different stages are reproduced in Fig. 126. Before the middle of the eighteenth century, two other especially noteworthy accounts were published. In 1736, Reaumur, a Frenchman, added some accurate details, with good figures, of its habits in the fruit, and in preparing for transformation. Ten years later, Roesel, a German writer, devoted several pages of his wonderfully interesting "Insect Recreations" to a very good account of the habits and life of the insect based upon original observations; the hand-painted pictures illustrating this have never been excelled in color since. The next year, 1747, apparently the first English account, by Wilkes, appeared. He compiled briefly from Roesel, but rendered his account especially noteworthy since he then gave to the insect the common name by which it is today recognized by all the English-speaking peoples.

During the next century and a quarter much was written of the insect in Europe, and considerable was added to our knowledge of some of the

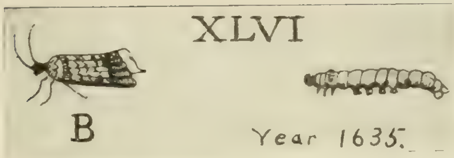
details of its habits and life. The most noteworthy German discussions during this period, from 1750 to 1875, were those of Schmidberger, Ratzeburg, and Noerdlinger. The excellent discussions by "Rusticus" (1833) and by Westwood (1838) still remain the best in the English literature. Among the best discussions in the French literature are those of Goreau (1861) and Boisduval (1867).

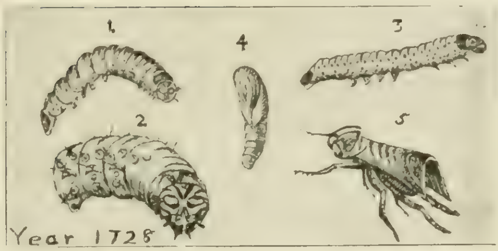
Although the insect had been introduced into America many years before (its introduction and spread in America is discussed later on) it seems to have been first noticed in American literature in 1819. Mr. Joseph Tufts, of Charlestown, Massachusetts, then published an account of rearing a moth, instead of the plum curculio, which had been previously thought to be the sole cause of wormy apples in America. Thatcher had made the same discovery when he wrote the second edition of his American Orchardist in 1825. This is apparently the first notice of the insect in any horticultural book, and, although Europeans had been writing of it for nearly two hundred years, it is a curious fact that, so far as we can glean from the literature, it remained for this American writer to make the first suggestion for controlling the insect. Apparently it was not realized untll 1832, when Doctor Harris called attention to the fact that the insect which caused wormy apples in America was the same as the well-known European insect. Only two noteworthy discussions of the insect appeared in American literature during the next thirty years. In 1841 Doctor Harris gave a very good account in his Insects of Massachusetts; and in 1846 Miss Morris published in the *American Agriculturist* some original observations, accompained by the first American picture of the insect. This picture is reproduced in Fig. 126.

The American literature of this pest since 1864 is doubtless nearly as voluminous as that of all other countries combined. During this period the following Americans have made notable additions to our knowledge of the insect and how to combat it: Trimble (1865), Walsh (1868), Riley (1868, 1873), Le Baron (1873), Cook (1875, 1888), Cooke (1881), Chapin (1883), Atkins (1884), Goff (1886), Forbes (1886, 1887), Wickson (1887), Howard (1888), Gillette (1889, 1891), Popenoe (1889), Washburn (1891, 1893), Koebele (1890), Munson (1892), Lodeman (1892, 1893), Marlatt (1894, 1895) Smith (1894, 1897), and Card (1897.) The best and most comprehensive discussions of the insect are those by Le Baron, Cook (1875), Cooke (1881), Howard (1888), Gillette (1891), and Washburn (1893).

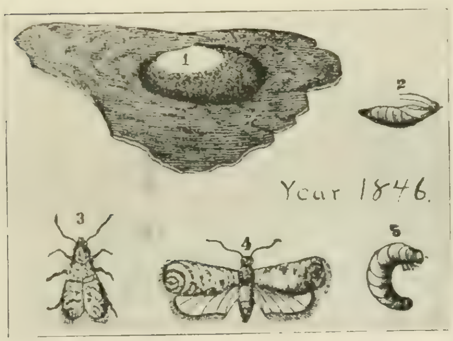
## GEOGRAPHICAL DISTRIBUTION OF THE INSECT.

The native home of this insect, like that of its principal food, the apple, was doubtless Southeastern Europe. It is now a cosmopolitan pest, occurring in nearly every corner of the globe where apples are cultivated. It is especially destructive in Europe, the United States, and Canada, and in the English colonies of South Africa, Australia, Tasmania, and New Zealand. It is said to have been seen in Victoria about 1855, in Tasmania at least as early as 1861, in New Zealand in 1874, and in South Australia and South Africa about 1885. It has been a serious pest in Canada for many years, but it seems to have not yet gained a foothold in British Columbia. In 1871 Zeller reported having received it from Brazil.




A GROTESQUE OLD GERMAN PICTURE. (FROM FRISCH




THE FIRST AMERICAN PICTURE

126.—Some Historical Pictures of the Codling-Moth.

*Its introduction and spread in the United States*—It was probably introduced into the United States from Europe in packages containing apples or pears. Just when the insect arrived in America will doubtless never be known. It may not have been until about the middle of the last century, for we find no references to "wormy apples" until after the plum curculio began to be discussed in the literature. For many years the cause of wormy apples in America was thought to be the plum curculio. Apparently it was not until 1819 that this mistake was discovered by breeding a moth from the supposed grubs of the curculio. At that time wormy apples and pears were common near Boston. By 1840 the insect had become a serious pest in the New England States, and was common in Central New York. A few hints here and there in the literature give us some idea of its westward progress. It is said to have been unknown in Illinois in 1849, and to have not invaded Iowa until about 1860. During the next decade its westward progress must have been rapid, for it reached Utah soon after 1870, and appeared in California in the spring of 1874.

The insect is now recognized as a pest in nearly every section of the United States where there are bearing apple orchards.

*How it is spread*—As the worm often goes into the barrel or other packing-case with the fruit when it is picked, and as it finds there in a suitable place to spin up and undergo its further tranformations, it is thus often transported for longer or shorter distances. This is doubtless the principal method by which the insect has been distributed, whether from one state to another or from one continent to another. When these receptacles are emptied of their fruit at its destination, they are often thrown one side without a thought that adhering to the sides and tucked away in the cracks there may be a dozen or even a hundred of the little worms in their snug cocoons, only awaiting the proper season to develop into the parent insects, which usually have little trouble in finding a suitable place in which to start their progeny.

## ESTIMATED LOSSES FROM ITS RAVAGES.

Evidently this insect has been noticeably destructive in orchards, that is, it has ranked as an insect pest, since the earliest times; for Pliny wrote in the first century of the Christian era that apples and pears "are very much worm-eaten in some years." Judging from recent reports, the percentage of wormy fruits at the present time is nearly as large in many parts of Europe as it is in America. Conservative estimates put the annual loss from its ravages, in all countries where it is noticeably destructive and but little is done to check it, at from twenty-five to seventy-five per cent. of the crop of apples; but with pears the loss is usually considerably less. Where modern methods of combating the insect are practiced, this percentage is often reduced one-half or more.

We have seen but two estimates of how many dollars this pest may cost fruitgrowers annually. In 1877, Professor Forbes, after making careful experiments and observations, and making all allowances for modifying circumstances, reached the conclusion that the annual loss due to the apple worm in the State of Illinois must reach the enormous total of $2,375,000, or

one-half the value of the average apple crop. In 1892 the insect is said to have caused a loss of $2,000,000 to the apple growers of Nebraska.

Through the kindness of the *American Agriculturist* in furnishing us with the statistics, we will hazard an estimate at the annual tribute which our New York apple growers pay for the ravages of this pest. The average annual crop of apples in New York now amounts to about five million barrels; as $1.50 per barrel would seem a fair average valuation, the total valuation of the annual crop may be estimated at $7,500,000. Although many New York fruitgrowers are fighting this insect with modern methods, we think that the wormy apples would constitute at least one-third of the total crop. That is, New York fruitgrowers yearly furnish $2,500,000 worth of apples to feed this insect; and there must be added to this at least $500,000 worth of pears (certainly a low estimate for New York) which the same insect renders worthless. This makes a tax of $3,000,000 which a single insect levies and collects each year from the fruitgrowers of our state.

### ITS FOOD.

The insect feeds mostly upon fruits, and is above all an apple pest. It has also worked in pears from the earliest times; in fact, it was first named a "pear-eater" in 1635. (See this quaint account in Fig. 126). Sometimes the insect works in pears as freely as in apples, but usually the percentage of wormy pears is considerably less. Wild haws, crab apples, and quinces are also quite freely eaten by the worms. Sometimes the insect works in the stone fruits. In 1868, Saunders reported it as quite destructive to plums in Canada, and it has recently been found in plums in New Mexico. About 1870 it was found to have acquired a taste for peaches in this country, and a little later it was bred from apricots. In 1893 Koebele found it infesting cherries in California. It has also been found in Europe in nearly all of these fruits.

There are several European records of the occurrence of the insect in walnuts and oak-galls. These reports were carefully sifted by Doctor Howard in 1887, and the conclusion reached that the evidence was not sufficient to definitely prove that the insect does sometimes feed upon walnuts or oak-galls. We have seen no further conclusive evidence on this point. In 1869, Doctor Riley recorded having a specimen of the moth which had been bred from the sweetish pulp of a species of screw bean (*Strombocarpa monoica*) which grows in pods, and which was obtained from the Rocky Mountains.* In 1894, Bruner, of Nebraska, reported that perhaps the insect fed upon the seed-buds of roses.

### ITS NAME.

*Popular name*—When the insect was first discussed in 1635, it was named the "pear-eater." It was next called the "fruit worm in pears and apples,"

* One instance is recorded where the insect apparently took an inclination to literature and mutilated some books to a considerable extent. Apples had been stored near a library and the worms upon leaving the fruit and seeking a place to transform, gnawed their way into some of the books and there spun their cocoons. We also encountered this literary habit of the insect when infested apples were left near books on the office table where this is being written.

in 1728; and from this has come the common names, "apple and pear worm or moth, fruit worm, fruit moth," and others, under which the insect is now discussed in nearly all publications except those in the English language. While the very appropriate name of "apple worm" is also often used by English and American writers, they usually discuss the pest under the perhaps less suggestive name of "codling moth."

This name was first given to the insect in 1747, by Wilkes, an English writer; as he figures a codling tree (the name then applied to a kind of apple tree), in connection with his account, this doubtless suggested the name. The word "codling" is doubtless a corruption of the old English word "querdlyng," meaning at first (in the fifteenth century) any immature or half-grown apple, then in the seventeenth century being applied to a variety suitable to be cooked while still unripe, but the peculiar codling shape, seems to have determined its modern application to certain varieties of apples. At the present time, most horticulturists and some entomologists are spelling the name "codlin;" and sometimes the form "coddling" appears. Neither of these forms or variations have any etymological evidence to support them, and the name of the insect should be spelled "codling moth;" as originally given in 1747.*

*Scientific name*—The name by which this insect is recognized by scientists the world over, was given to it by Linnaeus in 1758. This great naturalist named it *pomonella*, and his description of it consists of only six words: "Alis nebulosis postice macularubra aurea."†

As our knowledge of the world's insect fauna advanced, the generic position of this insect was changed from the *Tinea* of Linnaeus through *Pyralis*, *Trotrix*, etc., until now all scientists agree in calling it by the generic name (which corresponds somewhat to our sirname) of *Carpocapsa*, which was proposed in 1830. This name comes from two Greek words meaning "I eat fruit greedily." The specific name comes from the Latin word for apple. The scientific name of the insect, *Carpocapsa pomonella*, thus aptly expresses its characteristic habits.

* The form "codlin" was used as early as 1715 in connection with a kind of apple, but seems not to have been used in speaking of the insect until a century or more later. Nearly all prominent horticulturists and most English and Australasian writers now use the form "coodlin-moth," but nearly all American entomologists still spell it "codling moth." While the shorter form thus has the sanction of good usage, its only excuse for existence, so far as we can learn from those who use it, is that it is shorter and thus saves time in writing. The shortening makes it a different word, both in form and pronunciation. The encyclopædias offer contradictory and unreliable evidence. The dictionaries are our most reliable sources of information on on such questions and although both forms are given in most of them, we find that "codlin" is considered by the Century Dictionary as practically obsolete, and by the Standard Dictionary is recognized simply as a variant. Still stronger evidence in favor of the incorrectness of "codlin" is the fact that the original word is made up of "cod" and the old English diminutive suffix "ling;" and it is manifestly an inexcusable violation of etymological rules to drop the "g" of the "ng" of this suffix, thus making practically a new word, simply for the sake of brevity in writing, not in speaking. The most reliable authorities on compounding words also use the hyphen in the name, thus, "codling-moth." As to the form "coddling-moth," noted etymological authorities (the Century and Murray's New English Dictionaries) agree that there is doubtless no connection between the verb "coddle" and "codling," meaning an unripe apple; the resemblance is purely accidental, the verb appeared later, and there is no required precedent form of "coddling-apple."

†In 1775, Fabricius gave it the name of *pomana*, and a year later it was named *pomonana* by Schiffenmuller. It is a curious and, to us, an unexplainable fact that nearly all continental European writers on economic entomology should still use this name, *pomonana*. The fact that the same insect was described and named by Linnaeus as *pomonella* eighteen years before, and thus has priority, seems never to have been questioned. Why *pomonana* should still be used seems a mystery.

### HOW THE INSECT LOOKS.

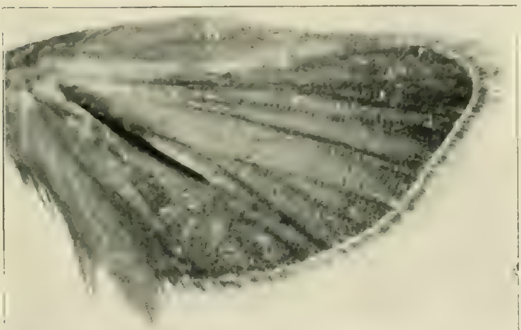
Who has not, in bitting or cutting into an apple, unceremoniously disturbed a little, flesh-colored caterpillar in its home, the familiar worm-eaten interior? When full-grown, this apple worm is about three-fourths of an inch long, and varies in color from whitish, through flesh color, to sometimes quite a distinct pink. Some have thought that this variation in color may be due to the different varieties of apples infested. The general characteristicts of the worm are shown in the enlarged Fig. 127. It can always be distinguished from the grubs of the plum curculio, which are often found in apples, by the presence of distinct legs, three pairs of true legs and five pairs of false or pro-legs. The head is brown in color, and the first thoracic and anal segments each bear a similarly colored shield. The body bears a few short hairs arising from small, often indistinct, blackish spots. These piliferous spots are often very distinct on the young worms, as is shown in Fig. 132.

*The adult insect or codling moth*—If no mishap occurs, each of these little caterpillars just described develops into the adult insect—a moth. Although such an exceedingly common and important insect pest, there is doubtless not one fruitgrower in ten who has ever seen the parent insect—the moth. It is a beautiful little creature whose front wings, when seen at a little distance, have somewhat the appearance of brown watered silk; when closely examined, they will be seen to be crossed by numerous gray and brown lines of scales, scalloped something like the plumage of a bird. Near the hind angle of each front wing there is a large dark-brown spot marked with streaks of bronze or gold. The hind wings are of a lighter greyish-brown color, darker toward the outer margin. The pictures of this moth (all of which are natural size, except two which are twice natural size) in Fig. 128 give one but a faint idea of the artistic beauty of this pretty creature. An artist who once painted for us a picture of this moth thoroughly appreciated the beautiful coloring with which nature has endowed it. As is shown in the lower group of Fig. 128, the moth varies considerably in size and general coloring; the moth in the center of this part of the figure is represented at rest and shows how nicely the markings on the front wings match when the wings are folded, thus giving the insect quite a different appearance. The peculiar coloring, and especially the habits (discussed further on) of these pretty litle moths, largely explain why our fruitgrowers are not familiar with the parents of one of their worst insect foes.

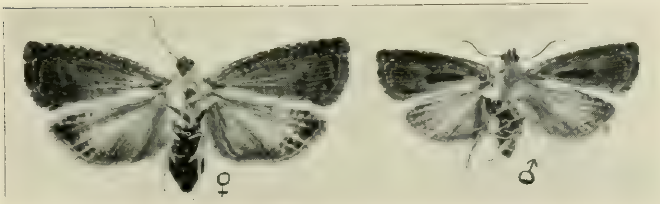
*How the male and female moths may be distinguished*—There are at least two characteristics by which the sexes of the adult insect may be quite readily distinguished. One of these was discovered by Zeller in 1870, and is shown, much enlarged, in Fig. 129. It consists of a narrow pencil of rather long black hairs situated in a slight furrow on the upper surface of each hind wing of the males only. Sometimes this distinguishing mark is not easily seen, except with a lens.

We have in our collection at the university over a hundred bred specimens of the codling moth, and while separating the sexes of these by the aid of the character just mentioned, we accidentally discovered that the males

127.—The apple-worm enlarged about three times.



129.—Hind wing of male moth, showing narrow black pencil of hairs, much enlarged.




130.—Male (on the right) and female moth, twice natural size, as seen from beneath. Note characteristic black spots on front wings of male only.

bore another much more conspicuous, yet constant and peculiar mark. In Fig. 130 are shown a male on the right and a female moth, twice natural size, as seen from beneath. It requires but a glance to see that on the underside of each front wing in the male there is a distinct, narrow, elongate, blackish spot, which is entirely lacking on the female. The spots consist simply of a group of blackish scales. The spot extends nearly to the base of the wing, and is more distinct on some specimens, but in our experience it has always been distinct enough to render it an easy matter to distinguish the males at a glance, no lens being necessary. We cannot understand how this sexual marking could have escaped the notice of entomologists for a couple of centuries. Doubtless others have seen these spots, but we have not been able to find the slightest hint that they might be a sexual characteristic either in systematic or economic discussions of the insect.

### THE STORY OF THE LIFE OF THE CODLING MOTH.

Perhaps the biography of no other insect pest has been written so often as that of the codling moth. Begun by Goedaerdt in 1635, and considerably extended by Reaumur in 1736, it was fairly well understood by Roesel as early as 1746. Since then the insect has been studied under many varying conditions in nearly all climes, and naturally different observers have been able to add many interesting details in regard to variations in its habits and life-history. Yet there are many interesting things to be learned about this common insect pest before its complete biography can be written. Our story of its life which follows is the result of a critical study of all of the biographies available, supplemented by many personal observations on the insect in all its stages. This story may very properly begin with that stage in which life begins for the insect.

### THE EGG.

It is a curious and striking fact that it is only within the past few years that anything definite has been recorded about the egg itself, in which so common and important an insect pest begins its life. Recent observations in this connection have brought out some facts which are of vital importance to the fruitgrower.

*Historical notes*—By whom or when the eggs were first seen, we have been unable to determine. In spite of the fact that nearly every account since Roesel's in 1746, contains definite statements regarding where they are laid, and as early as 1855 we find it stated that they are said to be of a pale, yellowish-red color, yet there is no definite evidence to show that the eggs were ever seen on an apple before 1870, and perhaps not until nearly twenty years later. The eggs have often been taken from the body of the moth, and Riley's description of them as "tiny yellow eggs" (1869), and Fernald's brief description (Bull. 12 of Mass. Expt. Sta., 1891) were undoubtedly made from eggs thus obtained. If Cook saw numbers of the eggs, as he states, in 1874, on or in the calyx of the young fruit, it seems strange that he has never given us a hint as to how they looked, and that no other observer since has ever found them on or in, although sometimes near, the calyx. In 1881, Cook saw eggs which a codling moth had deposited in a vial, and in 1882, Miss Walton states that some of the moths laid a lot of eggs in her cyanide bottle, but her description does not apply to any of the eggs we have ever seen.

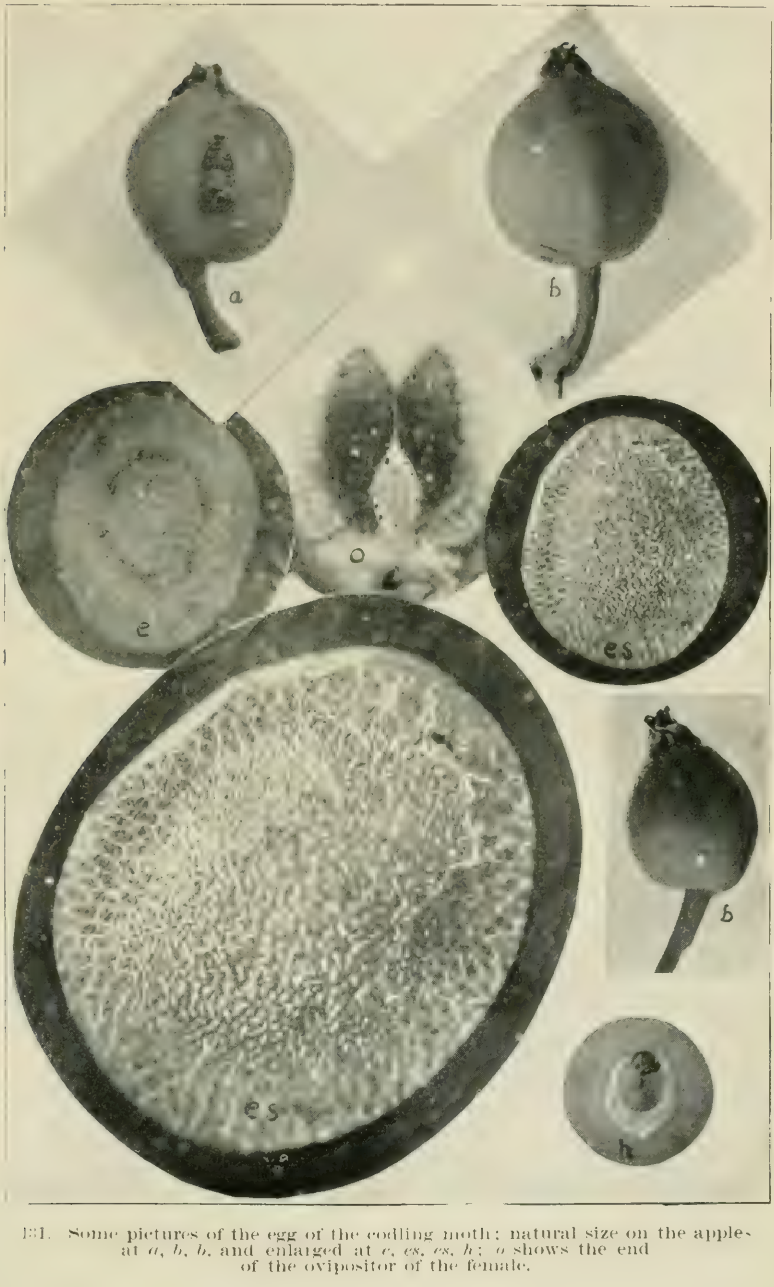
The eggs were undoubtedly seen on the fruit by Koebele and Wier in California in 1889 (Insect Life, II., 84), and by Wight in New Zealand in 1891 (Insect Life, III., 394.) But none of these writers tell us how the eggs looked. It is a notable fact that, after ravaging apple orchards for centuries, and after undergoing the closest scrutiny by many competent observers, the first picture and accurate description of the egg should not have appeared in the literature until 1893. In 1892 Mr. F. L. Washburn made the first careful observations upon the eggs, and his results were published in 1893, in Bulletin 25 from the Oregon Experiment Station. His picture of the egg is not quite accurate, but we cannot understand why such important observations should have been almost entirely overlooked by later writers. In 1895, the eggs were described and poorly figured by Goethe in Germany. He built a cage over a small tree, and, introducing some of the moths, soon got eggs and recorded their development. In 1896 the writer, and in 1897 Mr. F. W. Card in Nebraska, recorded further observations, quite at variance with the commonly accepted ideas regarding the egg-laying habits of this insect.

*How the egg looks*—Fortunately we were able to get some life-like photographs of the eggs of the codling moth and these are reproduced in Fig. 131. The small whitish spots on the apples at *a* and *b*, *b* in the figure represent the eggs' natural size, just as they were laid on the fruit by the moth. At *e* is shown one of the eggs much magnified, and *es* and *es* are pictures of the egg-shell, greatly enlarged. These pictures give a good idea of the shape, size and general appearancs of the egg. They have been aptly characterized as resembling a minute drop of milk adhering to the skin of the fruit.

The egg is a thin, scale-like object, not quite so large as the head of a common pin (it measures from .96 to .99 millimeters by 1.17 to 1.32 millimeters), and is of a semi-transparent, whitish color, often with a yellowish tinge, which is sometimes quite pronounced. Unless one has seen the eggs they could not be readily discovered on an apple; those on the apples at *a* and *b*, *b* in the figure were unnaturally whitened to bring them out in the reproduction. After one has become familiar with the eggs it is a comparatively easy matter to find them by turning the fruits around; when the light strikes the egg just right it can be quite readily seen. As the pictures in Fig. 131 show, the whole surface of the shell, when viewed under a microscope, is quite rough and is marked with an irregular network of fine ridges extending from the edge over about one-half of the surface, but not over all of the surface as represented in Washburn's picture.

*Where and when the eggs are laid*—In the light of recent observations it seems remarkable how the notion that the eggs of this insect are laid on or in the so-called calyx or blossom end of the fruit, has clung to the literature for nearly a century and a half.

Roesel was apparently the first one to make any definite statement regarding oviposition. He said in 1746: "The female places her impregnated eggs singly either below at the stem end or above at the blossom end of the fruit." It 1833 "Rusticus" wrote that the moth lays its eggs "in the eyes, one only in each, by introducing its long ovipositor between the leaves of the calyx, which form a tent above it that effectually shields it from any casualty." In 1855 Noedlinger wrote that "according to some the moth deposits its eggs upon the fruit itself, according to others, usually upon the calyx or between the calyx lobes or in the stem cavity. Undoubtedly all of these views are correct." The fact that the worms do often enter at the




131. Some pictures of the egg of the codling moth; natural size on the apples at *a*, *b*, *b*, and enlarged at *e*, *es*, *es*, *h*; *o* shows the end of the ovipositor of the female.

blossom end, and sometimes near the stem or even on the side of the fruit, was apparently the only foundation for the common notion that the eggs must have been laid at these points.

However, in 1889 and 1891, observers in California and New Zealand noticed that the eggs were laid almost anywhere else on the fruit than in or on the calyx; some were even seen on the stems of pears. In 1892 Washburn found the eggs "placed on both the sides and the top of the fruit." In the spring of 1896 we saw the egg of the codling moth for the first time; a moth had been induced to lay it on an apple in one of our cages. A little later we had no trouble in finding many eggs in orchards. In confinement we found that the moths laid their eggs almost anywhere it happened, on the sides of the cage, on the leaves or bark of branches placed in the cage, and sometimes several eggs were laid in a cluster, overlapping each other; Goethe had a similar experience in Germany in 1895.

During the past two years we have seen hundreds of the eggs on apples in New York orchards and have never yet seen one on or down in between the calyx lobes on the so-called blossom end. We have seen eggs near the calyx, in old curculio scars, near the stem, and have found what appeared to be codling moth eggs even on the leaves of the tree. Most of the eggs we found were glued to the skin, apparently without much choice as to location, on the smooth surface of the fruit, as shown at *a* and *b, b* in Fig. 131.

During the past year Mr. Card has found the eggs in Nebraska. He states that "instead of being laid in the calyx, we find that the eggs are laid exclusively on the upper surface of the leaves, in the orchard, though in confinement they may be laid anywhere. They are usually found on leaves of a cluster associated with apple."

In the light of these definite facts, the old stereotyped notion that the eggs are usually laid in the calyx, must be discarded. The eggs may be glued anywhere it happens to the surface of the fruit, to the stem, or even on the adjacent leaves. A glance at the ovipositor of the moth, represented at *o* in Fig. 131, shows that it is only adapted for laying eggs on the surface of the fruit or leaf. It is quite flat and hoof-like in appearance, and strongly beset with hairs. The eggs of the second or more broods, wherever such occur, are probably laid in similar situations; Koebele found them in California in August, 1889, on the stem, on the fruit near the stem, on the upper half and near the calyx of pears.

It seems that there has been considerable difference of opinion on the important question of when the eggs are laid; that is, at what stage in the development of the fruit are they laid. The records on this point vary from "just before the petals fall" to "nearly a month after the blossoms dropped." The common notion has been that the eggs were laid soon after the blossom fell, but apparently with no definite evidence to support it. When Koebele and Wier first found the eggs in California, the fruit was about an inch in diameter. In 1889 Gillette noted in Iowa that no worms hatched until nearly a month after the blossoms fell, and the apples were then an inch in diameter. Both in 1896 and 1897 we were unable to find any eggs on either early or late varieties of apples in orchards at Ithaca, New York, until the fruit had reached the size shown at *a, b, b,* in Fig. 131; this was during the last week in May, and the blossoms had been off for a week or more, and the calyx lobes had drawn together. Furthermore, moths did not begin to emerge in our cages in any numbers until a few days before we found eggs

in the field, or not until after the blossoms had fallen even from later varieties. Mr. Card's careful observations in Nebraska in 1897 add corroborative evidence to the above. He found the first eggs on June 3 and the first worm on June 12, while the petals had fallen from most varieties by May 10.

Thus, from the only definite evidence we have, one cannot escape the conclusion that, in the northern half of the United States at least, most of the eggs of the codling moth are not laid until a week or more after the petals of the blossoms have fallen from most varieties of apples ;* or usually during the latter part of May and the first half of June.

The date of the falling of the blossoms varies considerably in different years, depending upon the weather conditions, which may cause spring to open early or late. As these same conditions affect the date of the emergence of the moth, in general the above statement regarding the egg-laying of the insect will hold good.

The observations of Goethe in Germany, show that most of the eggs are laid at night, when the moths are the most active.

*The number of eggs and the egg-laying period*—Several guesses have been made of how many eggs one codling moth may lay, and the estimates vary from two dozen to two or three hundred. There seems to be no definite observations upon this point except what has been learned from an examination of the ovaries of the female. In 1873 LeBaron recorded that he found from forty to fifty tolerably developed eggs and a considerable number of undeveloped ova ; that is, he found eggs in all stages of development in the ovaries. This shows that the egg-laying period must last for several days. Cooke records having a vial containing eighty-five eggs laid by one moth. Thus, the number which one female lays may reach nearly a hundred.

As to how long after the emergence of the moths in the spring before egg-laying begins, accounts differ from forty-eight hours (Cooke) to six or eight days (Washburn).

Another stereotyped notion which has been handed down in the literature for more than a century, is the statement that "the codling moth has the wise instinct to lay but one egg on the same apple, and what is still more remarkable, she must have the instinct to avoid those apples which have been already appropriated to this purpose ; since, otherwise, we should oftener find more than one worm in the same apple" (LeBaron). We have often seen two eggs on an apple no larger than the one shown at *a* in Fig. 131, and in one case we found five eggshells, or perhaps sterile eggs (as we found no worms in the fruit) on such an apple : Koebele counted eleven eggs on a pear in California in August.

*Mortality among the eggs*—Our observations agree with those of Washburn, Goethe, and Card that many apparently sterile eggs are laid by codling moths.

*In the report of the Government Entomologist at the Cape of Good Hope, South Africa, for 1896, which has just come to hand, Mr. Lounsbury records (p. 11) the following in regard to this phase of the codling moth: "The insects were ovipositing at the time of my visit (in October). Not many eggs were found, but curiously enough, few of these at the blossom end of the fruit, where they are said to be usually placed. At this time (October 20) some fruit was fully an inch in diameter, and already contained the caterpillars, while unopened fruit buds were yet common on the trees, and many of the insects had not yet emerged from their cocoons. Such irregularity in the appearance of moth and in the setting of the blossoms, make repeated applications of insecticides necessary."

*Duration of the egg stage*—Roesel stated in 1746 that the eggs hatched in eight days. Later observers record a variation of from four to ten days. The eggs under our observation hatched in about a week, and this is doubtless about the usual duration of this stage.

A day or two after the egg is laid, a narrow whitish or yellowish ring can be plainly seen through the shell. A day or so later this ring takes on a decided reddish tinge; it is visible in the picture of an egg at *e* in Fig. 131. Soon after this the black head of the developing caterpillar and the outline of its body can be plainly seen. At *h* in Fig. 131 is shown an egg with the little caterpillar almost ready to emerge.

THE YOUNG APPLE WORM AND ITS HABITS.

*How it gets out of the egg and its characteristics*—Roesel tells us in 1746, that the little caterpillar "comes out of that part of the egg where it lies on the fruit, so that the very small opening may not be observed, because it is yet covered by the eggshell which still adheres." We find no other hint in the literature on this point until Washburn observed in 1892 that the young worms "broke or ate their way through the shell and entered the apple somewhere else than at the spot occupied by the egg." A caterpillar which we saw emerge, came out of the egg near the edge at one end. In the picture of an eggshell at *es* and *es* in Fig. 131, one can see at the upper end a small black spot and extending from this to the right is an irregular whitish line which was the crack made by the worm when it pushed its way out.

A newly-hatched apple worm measures scarcely a sixteenth of an inch in length, and is of a semi-transparent whitish color, with a shiny black head and blackish thoracic and anal shields. Usually the body is marked with many quite distinct blackish spots, regularly arranged and each bearing a short hair. In Fig. 132, is represented an apple worm only a few days old, much enlarged, upon which these spots were very distinct.

*The first meal of the little apple worm*—We have seen some of the newly-hatched caterpillars eating their first meal. After emerging from the egg, those we saw wandered about upon the surface of the apple until they found some angular place like the point where the calyx lobes join the skin of the fruit, or near the stem, or in an old curculio scar, or where a leaf or another apple touched the one upon which the worm hatched; often they simply crowded in between two of the calyx lobes and got their first meal within the little cavity at the blossom end. In short, our observations agree with those of Koebele and Washburn that the young caterpillar enters the fruit somewhere else than at the point where the egg is laid.

When a suitable place was found, the worm often tunneled its way through the skin and went directly toward the core. Where a leaf or another apple touched, the worm sometimes ate away the skin for a space about as large as a pin's head, before burrowing in; in this case the entrance hole was closed with a network of silken threads in which bits of apple were intermingled. In one instance, a worm ate little holes through the skin near the stem in three or four places before it finally began its journey toward the core; other writers have noted this same habit of the young worms in first entering the fruit. Thus the young caterpillar may get its first meal at

almost any place on the apple, but usually this meal, or any subsequent meal for that matter, includes only a very small portion of the outer surface of the fruit. As has long been noted by writers, most of the young worms enter the fruit in the spring or early summer at the blossom end. They either crawl between the calyx lobes or tunnel into the calyx cavity at the point where the lobes join the surface of the fruit. Thus more often the young apple worm takes its first meals out of sight in the calyx cavity and is protected by the tightly closed calyx lobes.

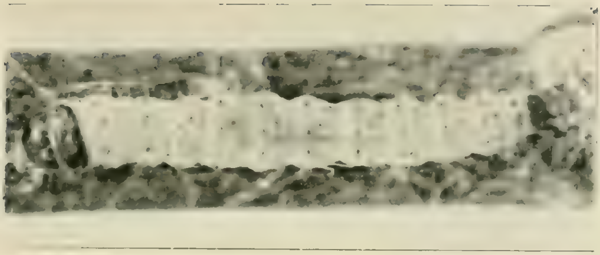
We have noted above that Mr. Card found most of the eggs of the codling moth laid upon the leaves instead of on the fruit in Nebraska. In confinement, he found that the young worms sometimes fed for twenty-four hours on the leaves where they hatched, and ate out quite large pieces, usually eating away one skin of the leaf and the inner tissue, leaving the other skin intact. Whether they fed upon the leaves to any extent in the orchard was not determined.

*Where it spends the first few days of its life.* Apparently the newly-hatched apple worm spends but a few hours of its life on the skin of the fruit. Whenever it enters at any other point than at the calyx, it usually soon begins to tunnel toward the core. However, seventy-five per cent. or more of the young worms enter the fruit at the blossom end, and our observations indicate that they spend several days feeding around in the calyx cavity. When the worms hatch, the blossoms have been off for two weeks or more and the calyx lobes have drawn tightly together (compare Fig. 146 and *a* and *b* in Fig. 131) forming a covered cavity in the blossom end of the apple: this does not happen in the case of the pear, as the central picture in Fig. 146 shows. This is a very important phase in the habits of the apple worm, as we shall see when we come to discuss "remedies."

All are familiar with the first indications that the apple worm has begun work; the masses of little brown particles which it thrusts out of the calyx are quite conspicuous, as shown in Fig. 133. These first few days of the apple worm's life, which are usually spent in feeding in the blossom end of the fruit, has proved to be the most vulnerable phase of the life of the insect. It is during this time that we kill it with a poison spray; just how this is done is discussed later on.

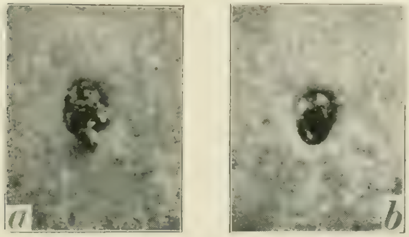
## HABITS AND GROWTH OF THE APPLE WORM INSIDE THE FRUIT.

The apple worm's objective point soon after it enters the fruit seems to be the core. It usually reaches the core in about a week, and there begins its destructive work on the seeds, of which it seems to be especially fond, and on the surrounding flesh. It feeds in or near the core during the greater part of the remainder of its life in the fruit. As it feeds, it increases in size and has to shed its skin from time to time to accommodate itself to this growth; it is said that the caterpillar sheds its skin four times while feeding in the fruit. As the worm increases in size, its head and thoracic and anal shields change in color from black to brown, and the small blackish piliferous spots, so distinct in the young worms, as shown in Fig. 132, usually become quite indistinct; we have, however, seen nearly full-grown apple worms on which these spots were still very distinct. The body of the worm also acquired a distinct pinkish or flesh color, sometimes even when the worms are only half grown.



132. Young apple-worm only a few days old. Note the distinct spots on the body. Much enlarged.

133- A wormy apple, showing the familiar mass of brown particles thrown out at the blossom end by the young worm.




134.—The "worm-hole" or exit hole of the apple-worm; enlarged, *a*, before the worm has left the fruit, and *b*, after it has emerged and pushed away the plug.

While at work in the blossom end or in tunneling to the core from any point on the fruit, the young worms apparently try to keep their home clean by throwing their excrement out at the entrance hole. Once fairly at work in the core, however, little or no trouble is taken to remove the grains of excrement: they are often found in the worm cavity fastened together by silken threads.*

*Preparations for leaving the fruit*—Several days before the apple worm gets full-grown, it proceeds to eat a passage way, usually by the shortest route toward the exterior. This exit tunnel often follows the entrance burrow, and thus often opens at the blossom end, but usually the external opening or, familiar "worm hole," occurs in the side of the fruit. When the worm reaches the surface with its exit tunnel, it uses the opening as a door, out of which it throws its excrement: it apparently keeps the hole closed with a network of silken threads, in which are mingled particles of apple bitten off by the worm and with grains of excrement. An exit hole thus stopped up is shown, enlarged, at *a* in Fig. 134. This "worm hole" often remains in this condition for several days, the caterpillar evidently feeding inside and making further preparations to leave the fruit forever.

The codling moth usually spends from twenty to thirty days of its life as a caterpillar feeding inside the fruit.

*Are two or more fruits ever attacked by the same worm?* Roesel believed that the worms often went from one opple to another, even though the apple fell to the ground and the worm had to climb the tree again. Later observers have only seen indications of where a worm has left one fruit and entered annother touching it while the fruits were still on the tree. There is no authentic evidence to show that more than two apples are ever entered by the same worm. Usually the apple worm gets its growth in the same fruit where it got its first meal.

*The number of worms in a single fruit*—Usually but one apple worm occurs in fruit, but several instances are recorded where two, three, or even four worms have been found in one fruit. Out of two hundred and one apples examined by Atkins, in Main, in 1882, nine had been penetrated by three worms each, and forty-seven by two worms each; in no case did a worm gnaw through into the burrow of another. When two or more worms are found in the same fruit, they are usually quite different in size, and may belong to different broods.

*Effect of their work on the fruit*—Usually fruit in which the apple worm is at work shows signs of a premature ripening. This is especially true of early varieties, and "windfalls" are often the final result. In the case of late varieties, however, the infested fruit often remains on the tree and ripens naturally with the others, the worms thus having but little effect on the fruit, except to render it unattractive to buyers and eaters. Usually wormy fruit is practically worthless for almost any purpose, but much of it is often fed to stock, or to us in the form of sweet cider.

*Reaumur thought this was purposely done by the worm to prevent the pellets from being thrown about in the cavity by the motions of the fruit. This may be true, or it may be more probable that, like many other caterpillars, this apple worm spins a thread wherever it goes around in its home, and the pellets simply get entangled in these threads.

HOW AND WHEN THE WORMS LEAVE THE FRUIT.

When the caterpillar is ready to leave the fruit it pushes away the plug of pellets, described above and shown at *a* in Fig. 134, and crawls out, leaving a round, blackish-looking "worm hole" as shown at *b* in the same figure. When this exit hole is found, one can easily tell whether a fruit still contains the worm or not, by the presence or absence of the plug of pellets. It is said that the worms leave the fruit mostly at night.

If the fruit has already fallen to the ground, the caterpillar proceeds to crawl to some secure and suitable place in which to begin its preparations for becoming a moth. Those worms which leave the fruit on the tree were seen by LeBaron in the orchard by lamplight to either let themselves down to the ground by a silken thread, which they spun as they went, and then crawl back to the trunk; or they crawled from the apple onto the branch and thence down the trunk. Cook, from some experiments made in 1875, thought that the worms seldom, if ever, dropped from the tree to the ground; and that at least one-half of them did not descend to the ground at all. Trimble records collecting a number of worms and putting them on the ground in the vicinity of an apple tree. They crept around at random for a little while, but, if not too far off, most of them were soon seen going in the direction of the tree.

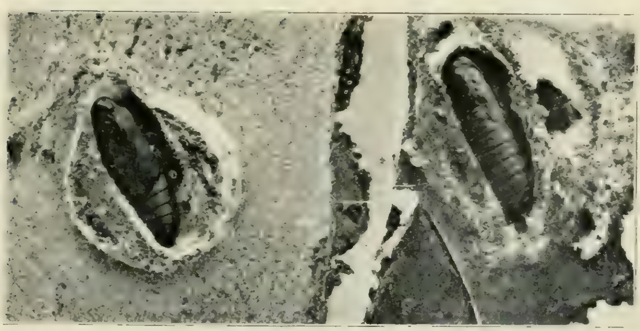
The date when the worms which enter the fruit in the spring get full-grown and leave, can not be stated definitely. For the irregularity in the appearance of the moths at that time is so great that oftentimes some of the earliest worms will be ready to leave when others hatched from later eggs will be just entering the fruit. In the latitude of Saint Louis, Riley records finding full-grown worms as earily as the fifth to the tenth of June. Usually, however, the early summer brood of worms in the latitude of New York do not mature until July and later. From the first of July until winter sets in, one can usually find at any time worms of all sizes in the fruit; and large numbers of them do not leave the fruit until it has been barreled or stored for winter.

THE COCOON.

*Where it is made*—After leaving the fruit, the apple worm next devotes its energies to finding a suitable place for its cocoon, in which to undergo its further transformations. Many of them find their way to the trunk, larger branches, or into the crotch of the tree, where they crawl into any crevice they can find under the rough, loose bark. Other worms find suitable quarters on near-by fences or trees, in piles of rubbish, under boards or chips, in stumps, in fact, almost anywhere, except in the ground or among the grasses or weeds.* In November, 1875, Beal made a very careful exami-

* Mr. Crawford records an instance in Australia where the worms took refuge in the pith of old raspberry canes growing under apple trees; twenty worms were found in one of these canes. In 1896, several raspberry canes, which had been badly infested with the cane-borer, were sent us from Ohio. In the pith, we found several apple worms snugly tucked away in their cocoons. In this case, the worms had evidently found an easy entrance to the canes through the large hole made by the borer when it emerged as a beetle. While breeding the insect here in the insectary, we have had the worms burrow into pieces of cork and work their way into books to spin their cocoons. Cooke says the cocoons are often found in California from one to six inches below the ground on the base and roots of the smooth-barked trees.

135.—Cocoons of codling moth as they were found attached to a piece of loose bark, natural size.



136.—Pupæ of the codling moth in cocoons, enlarged.

nation of several square feet of soil and grass under different trees which had borne or had had wormy apples sorted under them; no trace of the insect was found.

If the worms are carried into the storeroom or barreled with the fruit when it is picked, upon leaving the apples they spin their cocoons in the crevices and angles of the barrels, or anywhere in the storeroom, especially in any rags, papers, or clothes that may be lying about.

*How it is made.*—Having found a suitable place, the apple worm first usually hollows out with its jaws a little oval cavity, and then begins its cocoon. The cocoon is rather thin but quite tough and is made largely of silk in which are mixed bits of the substance on which it is being made. It is lined with a thin layer of white silk, and on the outside it is usually covered, and often thickened at some point, with more loosely bound together particles of the surrounding substance; this renders the cocoon quite inconspicuous. Several cocoons are shown, natural size, in Fig. 135, just as they appeared on the piece of bark when it was removed from the tree. Fig. 136 shows some cocoons enlarged, and it well illustrates their method of construction. In shape, the cocoons are adapted to the shape of the place in which they are built. Anyone can soon find these cocoons on old rough-barked apple trees after a little search at almost any time from August 1 until spring opens. Cooke states that a worm completes its cocoon in twenty-four hours. It is said that the cocoons made by the worms late in the season, and in which they expect to pass the winter, are tougher, thicker, and darker colored than those made earlier, from which the moths soon issue.

### HOW LONG AND IN WHAT CONDITION THE INSECT LIVES IN ITS COCOON.

Usually when the cocoon is made during or after August, the insect may be found therein as a caterpillar until the next spring. If the cocoon is made before August 1, its maker, the caterpillar, may change within three days to a very different looking object known as pupa. Cocoons containing these pupæ are shown, natural size, in Fig. 135, and enlarged in Fig. 136. The insect usually spends but two or three weeks, sometimes less, in the pupa state, whether the change to a pupa takes place in July or not, until the next spring. Thus the insect may spend less than three weeks of its life as a pupa in the cocoon, or it may occupy it as a caterpillar for ten months, and then as a pupa for two or three weeks longer. The reason for this seemingly great variation in the life-history of the codling moth will appear in the discussion of the next and very important phase of the subject.

### THE NUMBER OF BROODS OF THE INSECT.

For more than a century the statements which have been made regarding the number of broods of the codling moth during the course of a year have differed widely. Some writers record only one brood, others two, and some as many as three or more in a year. This variation has been the subject of considerable discussion in Germany, and more recently in the United States.

Beginning with Goedart's first account in 1635, the European records indicate but one brood north of latitude 50 degrees, that is, in England,

Holland, Germany (except possibly the southwestern portion), and the more northern countries. The evidence from Reaumur, Pissot, and Schmidtberger indicate two broods in France and Austria, or south of latitude 50 degrees; recent evidence from Italy indicates three broods there.

In America the evidence thus far submitted shows a similar, and in some instances, a more striking variation in the number of broods of the insect. The observations of Atkins, Harvey, and Munson in Maine, indicate one regular or full brood and a partial; in some years, possibly, nearly a full, second brood in that state. This statement will doubtless also apply to most of the New England States, and, so far as our observations indicate, it is also true of New York State.

In 1871 Mr. Chapin, of East Bloomfield, New York, found that by caging some of the insects in July that a second brood of the moths appeared in August (*Country Gentleman*, January 25, 1871). We have bred moths in August here at Ithaca from cocoons spun in July, and our observations indicate that in New York State the number of worms of the first brood which develop into moths the same season depends largely upon the weather conditions which affect the earliness or lateness of the opening of spring. In 1896, for instance, spring opened earlier than usual in New York and everything was very favorable for the development of insect life for several weeks, with the result that there was evidently nearly if not quite a full second brood of the codling moth, for a much larger percentage of the apples than usual were injured late in the season. We believe that there is always a partial second brood of the insect in New York, and in some years probably a full second brood in many parts of the state.

There is conclusive evidence of two full broods of the insect in Illinois, Iowa, Missouri, Kansas, Nebraska, and Colorado, with indications of a partial third brood in Southern Illinois, and in Nebraska and Colorado. In the higher altitudes of California there are apparently but two broods (Bull. 22, U. S. Div. of Ent., p. 89), while three broods appear in other parts of the state. Observations in Oregon and New Mexico indicate three broods there also.

The evidence submitted from New Jersey indicates some peculiar variations in the life of the insect in that state. In 1865 Trimble recorded that he found pupæ under some of his bands at Newark, New Jersey, on August 10, and on August 20 and 23 he found that "about one in five of the worms had transformed to moths;" thus demonstrating at least a partial second brood in that part of the state. In 1894 Smith recorded some experiments extending over three years, from which he recently concludes that "near New Brunswick there is positively a single annual brood only." But he admits that "south of Burlington County there is at least a partial second brood." In the same paragraph he also states that the moths emerge earlier at New Brunswick than Card records them in Nebraska, where there are at least two broods of the insect. It seems strange that there should be such a difference in the life of this insect within a distance of less than thirty miles in the same state. But there seems to be something peculiar about the conditions near New Brunswick, New Jersey, for Smith finds that other insects, notably the elm-leaf beetle, lead a different life there than they do only a comparatively short distance either to the north or south.

In 1895 Fletcher reported that "careful observations made during the last ten years convince me that in this part of Canada (Ottawa) there is

only one regular brood of this insect in the year. This is, I believe, the case as far west as Toronto. In the fruit-growing districts of West Ontario there are two broods, the second brood being invariably the most destructive."

From the above evidence we conclude that there is one well-defined brood and usually a more or less complete second brood of the codling moth yearly in the New England States, New York and most of New Jersey, and part of Canada. Two well-defined annual broods occur in Michigan, Illinois, Iowa, Missouri, Kansas, Nebraska, Western Ontario, and Colorado, with sometimes a partial third brood in some localities and seasons. In California, Oregon, New Mexico, and in the South there seems to be three broods annually. We should have more definite observations on this point in many states. It is not possible to define these different regions by parallels of latitude, for the variation in the number of broods depends upon differences in climate, temperature, and altitude.*

Whenever the first brood of worms transforms into moths the same season, this usually occurs late in July and during August, and the second brood of worms work from August on, many of them even completing their growth after the fruit is stored. In those parts of Europe where the insect is single-brooded, the moths do not appear from the winter cocoons until the middle of June and in July. The second brood is usually more destructive than the first, as it is more numerous and works in the later and more valuable varieties of fruit. In some years the partial second brood which works in New York State spoils many more apples than the first brood.

This question of the number of broods of this pest is of great practical importance in connection with the methods of combating it. We have learned how to quite successfully control it where there is one and a partial second brood, or even two broods annually, but where there are more than two broods we are not so successful.

### HOW THE SECOND BROOD WORKS.

Doubtless the eggs of the second brood, like those of the first, are laid anywhere it happens on the fruit or possibly on the leaves, but not so many of the young worms enter the fruit at the blossom end, many of them entering at other points. Instead of making their way to the core soon after entering, many of the worms of the second brood seem to feed for some little time in the flesh just beneath the skin near the point where they entered, forming there a shallow mine. This results in a large wormy spot which greatly disfigures the fruit, as shown on the two lower apples in Fig. 137; often a leaf may be fastened down to the fruit over the spot, as shown on one of the apples. In 1896 there was much complaint from New York apple growers on account of so much of their fruit having these wormy spots

* Mr. Marlatt suggests (Proc. Ent. Soc. of Wash., III., p. 228) that "Doctor Merriam's map showing the distribution of the total quantity of heat during the season of growth and reproductive activity, presents an interesting agreement in its zones with the available records in regard to the number of broods of this insect. * * * At least, a good basis is furnished for future observations." He thinks that the data thus far submitted indicates one annual brood in Doctor Merriam's transitional zone, two annual broods may be expected in the upper austral life-zone, and three annual broods in the lower austral zone.

on them late in the season; most growers did not realize that it was the work of their old enemy, the codling moth. Perhaps the more common method of work of this second brood, however, in many localities is shown on the upper apple in Fig. 137. That is, the worm enters the blossom end, but instead of soon making its way to the core, it extends its feeding grounds out into the fruit around the calyx, forming a shallow mine just under the skin. Sometimes the flesh is thus mined out for a distance of half an inch from the calyx, the worms often attaining their full growth there. Harvey records that in Maine, in 1888, three-fourths of the apples from some localities showed this work of the second brood of worms around the calyx. Whether the second brood often works in this peculiar manner in other parts of the country, especially where there is a third brood, we cannot say. It is probable that many of the worms which are hatched late in the season, of whatever brood, work in this manner.

### HOW THE INSECT PASSES THE WINTER.

Almost invariably the codling moth winters as a caterpillar in its cocoon. Differences in latitude, climate, or altitude seem to cause no variation from this rule.* Often some of the worms go into winter quarters in August. As worms of all sizes may be found in the fruit late in the fall, doubtless many of the young ones perish, unless they are lucky enough to be carried into the storeroom where they may continue feeding and finish their growth.

One can readily find these hibernating worms in the winter or early spring, snugly curled up in their cocoons, by carefully examining the loose bark on almost any old apple tree which bore much fruit the previous season. It is interesting to watch the caterpillars when their cocoon has been torn open, even in the winter. They soon bestir themselves and proceed to repair the damage at once. If removed from the cocoon they will spin another, and we have had a worm make two or three new and complete cocoons after being removed very early in the spring from the one in which it hibernated.

### WHEN THE MOTHS APPEAR IN THE SPRING.

Those hibernating worms which escape the birds during the winter, change to brown pupæ, shown in Fig. 136, in the spring, and in from two to three weeks the moths emerge. The date of the emergence of the moths depends much upon the place where the worms hibernated, and upon the weather conditions prevailing in the spring. Oftentimes the cocoons are spun in temporary storerooms in the fall, where the subsequent temperature is so warm as to cause the insect to transform considerably sooner than it naturally would on the trunk of a tree; or, if the wormy apples are placed in a cold cellar, the transformation of the worm may be unnaturally pro-

*Mr. Howard records an apparent exception to this rule. Specimens of the insect were received at the Department of Agriculture from Kansas, on November 15, were in the pupa state when sent three days before. They were kept in a warm room and the moths issued in January.

137.—Wormy spots made by the second brood of apple worms, half natural size.

144.—The hay-rope band in operation.

longed. The recorded appearances of the moths vary from March and the first half of April in California, through May and the early part of June for most localities in the northern half of the United States, and some moths have not emerged from cellars or storerooms until July 13 or later.

During the past two years we have made many visits to orchards early in the spring and have collected and examined hundreds of cocoons. These were placed in cages and the worms allowed to transform into moths, the date of emergence of the latter being noted. In 1896, we began collecting April 8 and found only caterpillars in the cocoons until April 28, when one or two pupæ were seen. In 1897, the first pupa was found April 27, and by the seventh of May only about one-fourth had pupated in the cocoons on the trees. The following table gives the dates of the emergence of the moths (with the number for each day) from cocoons collected in April, 1896 and 1897:

| 1896. | | | | 1897. | |
|---|---|---|---|---|---|
| *Date.* | *No. moths.* | *Date.* | *No. moths.* | *Date.* | *No. moths.* |
| May 3 | 1 | June 1 | 8 | May 24 | 4 |
| 4 | 1 | 2 | 6 | 26 | 4 |
| 5 | 2 | 3 | 7 | 28 | 5 |
| 7 | 4 | 4 | 6 | 29 | 3 |
| 10 | 4 | 5 | 9 | 30 | 8 |
| 11 | 5 | 6 | 4 | 31 | 6 |
| 17 | 5 | 7 | 5 | June 2 | 6 |
| 25 | 5 | 8 | 6 | 3 | 9 |
| 26 | 4 | 9 | 9 | 4 | 7 |
| 28 | 5 | 10 | 1 | 6 | 6 |
| 29 | 4 | 11 | 1 | 7 | 6 |
| 30 | 2 | 12 | 5 | | |
| 31 | 3 | 13 | 4 | | |
| | | 18 | 1 | | |
| | | 21 | 2 | | |
| | | 22 | 2 | | |

The above table shows that the moths may emerge over an unusually long period in the spring in Central New York; that is, from May 3 until June 22, or over a month and a half. Apparently a majority of them emerged in 1896 and 1897 during the last week in May and the first week in June. We found the first eggs in the orchard on May 28 in 1896, and recently laid eggs, evidently of the first brood, were seen as late as June 27.

*Compared with the blossoming period of apples.*—The date of the opening of apple blossoms varies considerably in the same localities in different years, depending upon the earliness or lateness of the opening of spring.

At Ithaca, in 1896, the petals had fallen from most varieties by May 10, and by May 28 the fruit was as large as shown at *a* and *b* in Fig. 131. In 1897, however, early varieties of apples were not in full bloom until May 11, and the petals had not fallen from the later varieties until May 20. In the same locality in 1892 Lodeman found that the petals were not off until June 6; in 1893 he found that the first blossoms opened on May 19, and a few blossoms remained on June 8. In 1892 the blossoms were off by May 20 in Pennsylvania. It is recorded that at Benzonia, Michigan, the season was so late in 1888 that there were no apple blossoms for Decoration Day, May 30; while the same year in California the apples were in bloom March 17. In 1889 the petals had fallen in Iowa by May 15, and in 1891 Munson records that the last blossoms were falling in Maine on June 11. In New Hampshire the

blossoms had fallen by June 9 in 1894. In 1897 Card reports that the season was later than usual in Nebraska, and the petals fell about May 8. In 1888 a calendar was kept of the date of blooming of different varieties of apples in Kansas (First Rept. Kan. Expt. Sta.); the calendar shows only a few days, less than a week's, difference in time of blooming of the earliest and latest varieties, most of them being in full bloom about April 21.

The above evidence in regard to the blossoming time of apples as compared with the dates of the emergence of the codling moths, indicates that the moths may begin to emerge about the time the apple trees are in bloom. But our breeding experiments and what little definite evidence there is on this point, indicate that the majority of the moths do not emerge until several days after the petals have fallen. Then allowing a few days for the preparation for oviposition, we should not expect, and, in fact, do not find eggs until a week or more after the petals drop. Another week must elapse before the eggs hatch, so that, theoretically, we should find but few worms until after the blossoms have been off for two weeks or more on most varieties: and this agrees with our observations and with the definite evidence recorded by Atkins, Gillette, Washburn and Card. There is no definite evidence that eggs have been seen on apples on the tree until the fruit has reached nearly the size shown at *a* and *b* in Fig. 131, or until it is from one-half to three-fourths of an inch in diameter.

We have gone into some detail to bring out the above facts, not only because they correct some old stereotyped notions, but because they have a very important bearing on the question as to when it is necessary to apply the spray to reach the worms the most successfully. As will be brought out more fully, with illustrations, in our discussion of the time to spray, it is necessary for fruitgrowers to watch the blossoming of their trees, and especially the development of the young fruit, for therein lies an easy and sure method of determining just when the spray can be applied to do the most good.

### HABITS OF THE MOTH.

It has long been known that the adult insect was nocturnal in its habits, usually remaining hidden during the day. The fact that the moth closely mimics the bark in its coloring, and its habits of moving about only at night, account for the fact that but few fruitgrowers have ever seen it. Koebele gives the following account of their habits in California: "On a hot and sunny day, while walking through an old apple orchard at 10 A. M., moths started up either from the trunk or lower leaves of nearly every tree and settled down again, generally higher up and on the upper side of the leaves exposed to the sun. From May 25 until the end of June there could be seen at dusk from twenty-five to fifty on each tree. The place is situated on the east side of the hills. About half an hour after the sun disappeared behind the mountains, and while it was yet visible for nearly that length of time on the opposite hill, the moths began to appear, flying with quick movements around the trees, chiefly near the tops, and settling down again upon the leaves or fruit from time to time. This was kept up until towards dark when they became less numerous. During this time both sexes may be readily collected with a long butterfly net. I have taken many near

the ground on the lower leaves and often distant from fruit trees. By their peculiar flight they are easily distinguished from any other species of moth." Goethe found in his experiments in Germany that the moths were the most active about 9 P. M. Most of the eggs are thus doubtless laid in the evening.

Unlike many other moths, the codling moth is not attracted to lights. This has been demonstrated several times by careful experiments with trap-lanterns in orchards.

The moth has a slender, pointed tongue with which it sometimes sips or sucks up sweet substances. LeBaron saw the moths feed freely upon lumps of moist sugar and slices of sweet apple which he placed in their cage. McMillan records that they willingly feed upon sweetened water, and that he has "seen those of the second brood feeding upon the yellow flowers of an autumnal composite (*Grindelia squarrosa*) in the dusk of evening" in Nebraska. The weight of evidence from careful experiments indicate that the moths are not easily attracted to alluring baits of any kind.*

How long a codling moth lives is not definitely known. In confinement most observers record that they all die in about a week. Washburn concluded from his observations that the life of the moths was from ten to fifteen days. One moth lived for seventeen days in one of our cages.

### BRIEF RESUME OF THE LIFE-HISTORY.

The codling moth appears in the spring about the time the blossoms are falling from apple trees, and, after a few days, glues its tiny scale-like eggs (see Fig. 131) onto the skin of the young fruit, or even the adjacent leaves, where they hatch in about a week. The little apple worm usually finds its way into the blossom end where it takes its first meal and where it remains feeding for several days, finally eating its way to the core. In about three weeks it gets nearly full-grown and makes an exit tunnel to the surface, closing the outside opening of the tunnel for a few days while it feeds inside. Emerging from the fruit it usually makes its way to the trunk of the tree where it soon spins a cocoon (Fig. 135) under the loose bark. Usually the first worms to thus spin up in June and July soon transform to pupæ (Fig. 136), from which the adult insect emerges in about two weeks, and eggs are soon laid from which a second brood of the worms hatch. In most of the more northern portions of the United States only a part of the worms of the first brood pupate or transform to moths the same season, but in the central, western, and southern portions there is a complete second brood, and in some portions even a third brood of worms annually. In the fall all the worms spin cocoons wherever they may be, either in the orchard or in the storerooms, and remain curled up in them as caterpillars until spring opens, when they transform, through the pupa, to the moth, thus completing their yearly life-cycle.

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*A Connecticut correspondent states in the *Rural New Yorker* for January 9, 1897, that "happening to pass a sweet-bough apple tree one evening in August, where a number of apples, half eaten by the chickens, were lying scattered about, I noticed a kitten busily trying to catch some small object. On investigation I discovered that the half-eaten apples were covered with codling moths. There were thousands of them, apparently feeding on the fruit. They were very active when disturbed. I procured a lot of old newspapers, and for half an hour or more I kept several fires burning brightly, while the kitten and I stirred them up. I don't think I succeeded in burning as many as the kitten caught. They carefully avoided the fires."

## HOW TO FIGHT THE CODLING MOTH.

The codling moth seems to have ravaged orchards for twenty centuries before anyone recorded any suggestions by which it might be checked.* During the past seventy-five years, however, so many schemes have been devised that it would require volumes to contain all that has been said pro and con concerning them. Believing that oftentimes it is just as valuable to a fruitgrower to know what not to do as it is what to do, and that one method may be more applicable or practicable under certain conditions than another method, we have thought it advisable to briefly discuss all of the so-called "remedies" that we have seen suggested.

In devising any method for combating an insect foe, the first thing that should be considered is, in what stage, or when is it the most vulnerable to attack? Recommendations for fighting the codling moth include schemes for reaching it in all stages and under all sorts of conditions. Most writers have considered that the insect is not so easily gotten at in either of the shorter stages of its life, that is, in the moth, egg, or pupal stages, therefore most of the remedial suggestions are directed toward the destruction of it in the caterpillar stage, in which it spends the greater part of its life.

### WHAT CAN BE DONE AGAINST THE MOTHS.

"Rusticus" said in 1833, that one could drive away the moths in June by making a smoking fire of weeds under valuable trees. This is possible, but hardly probable, and not often practicable. In 1839, Freyer suggested that the best way is to hunt out the moths on the trunk and leaves and kill them. He must have been joking, for we have never yet been able to get sight of the moth on a tree. Ratzeburg condemned the method the next year.

The insect-catching properties of the flowers of the different species of *Physianthus* have long been known, and there has been considerable discussion over the claim made by some that many codling moths were caught in these flowers. It was proposed to train these vines up the trunks of apple trees, surmising that the flowers, by capturing the moths, would thus protect the crop. Conclusive evidence has been recorded to show that these flowers have no attractions for codling moths.

The fact that many different kinds of moths are often attracted to lights or to alluring baits in large numbers, has led many to believe that the codling moth could also be lured in sufficient numbers to make it pay to build fires or to place trap-lanterns in an orchard, or to hang sweetened or other baits of various kinds in the trees. Many experiments have been tried along this line by such reliable observers as Riley, Cook, and Atkins, and so few codling moths were captured as to conclusively show the entire futility of attempting to check the pest in this way. Many collectors of insects also report very few captures of the moth at their lures or at lights. Most of the

*Of interest historically, is the fact, that so far as we can discover, the first one to even hint at any remedial measure was an American, a Mr. Thatcher. In the second edition of his American Orchardist, he shrewdly reasons that as the worms are said to spend the winter on the trunks of the trees, it would be well to scrape off all the loose bark and apply Forsyth's wash (consisting of soap-suds, lime, and cow-dung); this would certainly help in reducing the numbers of the pest.

reported captures of the insect in large numbers at baits or traps are the results of mistaken identity.*

There is one suggestion of considerable importance to be made in this connection. As many of the worms are carried with the fruit into the store-rooms in the fall, where they spin their cocoons, consequently the moths often emerge in the spring in considerable numbers and escape through the windows and doors. It would be a simple matter to put screens or mosquito netting over all openings during May, June, and July, thus effectually trapping the moths which would otherwise find their way to orchards and start a numerous progeny. The number of moths which sometimes emerge in these fruitrooms is surprising. Hundreds of cocoons have been found in a single apple barrel, and in one instance in California the openings in a fruit-room were screened and nearly sixteen thousand codling moths were thus trapped and killed between the middle of April and the end of August, nearly one thousand being caught in a single day, June 15. It would not be necessary to go to the trouble of catching all the moths in a room thus screened, for they would soon die a natural death.

## CAN WE KILL THE EGGS?

It is only recently that anyone has suggested the possibility of reaching the codling moth in its egg stage. Mr. Card reported from Nebraska in August, 1897, that "the eggs are very easily accessible, being laid as they are on the upper surface of the leaf. In a limited way, in laboratory experiments we have found that kerosene emulsion will destroy these, but we are not yet able to say whether a strength that may be safely used will prove effective in field work." Mr. Washburn seems to have been the only one to try any other experiments against the eggs. In 1892 he allowed a few apples, upon which eggs occurred, to remain in a solution of one pound of IXL (a mixture of lime, salt, and sulphur) about one pound of whale-oil soap, and about an ounce of paris green, in sixteen gallons of water; subsequently these eggs hatched.

Apple trees have been sprayed with similar substances. In 1878 Cook sprayed an apple tree weekly from May 15 till the last of June with a strong solution of soft soap, with the results that not a single apple was wormy, while an unsprayed tree had nearly three-fourths of its fruit infested. Whether the strong smell of the soap kept the moths away, whether the eggs were killed, or how the solution affected the insect, is not suggested. Goff has sprayed apple trees with kerosene emulsion once (June 11), and with McDougall's sheep dip twice (May 25 and 30), but with little or no effect on the codling moth.

It may be possible to reach the eggs with a spray in Nebraska, where they seem to be laid on the leaves, but our experience in trying to kill the eggs of insects leads us to fear that it will take a stronger mixture than the plant

*The use of baits has recently received considerable attention in Germany, and in *Der Praktische Ratgeber*, for 1895, is recorded an account of an experiment with glasses of apple jelly hung in the trees. We glean from the report that quite a number of codling moths were thus captured, about half of them being females.

will stand to accomplish the desired result. Whether the eggs can be reached as readily when they are laid on the fruit, can be determined only by experiment. On the whole, we doubt if the codling moth can ever be combated in its egg stage nearly so successfully and easily as at some other time.

### CAN WE REACH THE PUPÆ?

As the pupal period lasts only about two weeks, and is passed in the cocoon hidden in some crevice of the bark or in the storerooms, it offers but little opportunity for attack. Many pupæ are killed during the summer when the "banding" system (to be discussed later) is thoroughly carried out. Many of them could also be killed in the spring in storerooms by fumigating the room, as suggested by Wier, of California, with carbon bisulphite or hydrocyanic acid gas. But the insect can be just as effectually gotten at while it is yet a caterpillar, or in the fruitroom, even after the moths have emerged; so that although the pupæ can be reached to a limited extent and killed, we can fight the insect much easier and more successfully at some other time.

### HOW TO KILL THE APPLE WORM OR CATERPILLAR.

Having discussed the possible chances of reaching the insect in its moth, egg, and pupal stages, we now turn our attention to combating it in its more vulnerable stage, as an apple worm. From the time the caterpillar leaves the egg until it is snugly ensconced in its cocoon, it can be reached in several different ways, none of which, however, are a complete success.

*Jarring or picking infested fruit from the trees*—The fact that one can often easily detect the wormy fruit soon after the insect has begun work, by the pile of brown excrement thrown out at the blossom end (as shown in Fig. 133) led several orchardists about 1870 to adopt the practice of jarring or picking off such fruits and destroying them. In 1871, Mr. Chapin, of East Bloomfield, New York, reported that by this means he was able to preserve the fruit in an orchard of a hundred acres, at the rate of about an acre an hour, with two men and a boy. The men would knocked off the wormy fruit with poles about as fast as the boy could gather them into baskets. This simple expedient would be practicable nowadays in the case a of a few trees in a dooryard, but even there equally as successful results can be secured with less labor by other methods.

*The destruction of the "windfalls"*—Among the earliest recommendations made for the destruction of the codling moth, both in Europe and this country, was to destroy all "windfalls" as fast as they fell. Careful experiments by Forbes and Munson have shown that about eighty-two per cent. of these "windfalls" are caused by the codling moth; the observation of Le Baron, Beal, and Cook led them to conclude that about one-half of the wormy apples which fell still contained the worms; many have also observed that the worms do not remain long in "windfalls." From these facts one can readily see that the prompt destruction of the "windfalls" would considerably lessen the numbers of the pest, but it could be only partially effective since about half of the worms leave the fruits before they fall. Many have reported good results from pasturing hogs or sheep in orchards to eat the "windfalls," and wherever this is practicable, it would prove a valuable

addition to other methods of warfare. In the case of a few choice trees in a dooryard, it would be a good, practicable plan to gather the "windfalls" by hand every few days and destroy them or feed them out to stock.

At best, however, the destruction of "windfalls" can be only partially effective against the codling moth.

*Trapping the worms on the tree trunk, or the "banding" method.* Upon leaving the fruit, the apple worm preferably seeks the shelter of the crevices and loose bark of the trunk of the tree before spinning its cocoon. This fact was known as early as 1746, but it was not until nearly a century later that Burrelle, of Massachusetts, discovered that thousands of the insects may be obtained "by winding round or hanging any old cloth in the crotch of the trees, from the time they begin to leave the apple till the time the fruit is gathered. I think at present the best remedy would be this: In the fall when the insects have crept into the cloth for winter quarters take the cloth from the tree and put it into an oven hot enough to destroy them." Other orchardists soon recorded similar observations, and finally, as a natural outgrowth of Burrelle's recommendation, Doctor Trimble, after a series of experiments with various "bands," in 1864, devised his famous "hay-rope band." A reduced copy of Doctor Trimble's picture of his hay-rope band in operation is shown in Fig. 144. In forming an ideal place for the apple worms in or under which to spin their cocoons this hay-rope band is equal to anything yet devised.

This "banding system" thus thoroughly inaugurated by Doctor Trimble soon became the principal and most successful method of warfare against this pest. It was largely practiced during the decade between 1870 and 1880, in many parts of the United States, especially in Michigan where it is said to have brought about a noticeable improvement in the apples from that state. Extensive experiments have been made since 1869 with bands of various kinds by Riley, LeBaron, Cook, Beal, Chapin, Wickson, Popenoe, Washburn, and Card; and within the past three or four years, the banding system has received considerable attention in Germany by Schilling. These experimenters differed in their conclusions as to what was the best band to use. Among those found the most practical and successful may be mentioned common straw wrapping-paper, 18x30, folded lengthwise thrice upon itself; rags of any kind; a very effective but rather expensive one was formed by lining one side of an old piece of sacking, four inches wide, with strips of lath; strips of old carpet; woollen cloths; old grainsacks cut into strips; felt paper sold for carpet lining; and strips of heavy express paper cut on a slight curvature and folded together once; while Trimble's hay-rope band was found equally effective, it was not nearly so convenient to make or use and was thus early discarded.* Any of the above bands are

*In 1870 or 1871 there was patented and put on the market what was known as "Wier's shingle trap." It consisted of three shingles, separated for a slight distance and held together by a large screw through their center, by which they were also fastened to the side of a tree. The idea was that the worms in seeking a place to spin upon the trunk of the tree would be allured to these shingles. The trap could be easily detached from the tree and by turning the shingles the insects between them could be quickly crushed. This trap aroused considerable interest at the time, but careful comparative tests by Riley and LeBaron soon showed that it was not nearly so effective as almost any kind of a band which went completely around the tree; and Wier's shingle trap was soon discarded.

easily made and quickly applied by placing them around the tree and either putting a tack through the overlapping ends and into the tree or else by simply tying a cord around the middle of the band. To work the most successfully, the tree should be scraped quite smooth where the band is applied; the band should be arranged to present one or more folds in which the worms like to spin their cocoons; and two bands should be put on each tree, one near the crotch and the other near the base, thus offering convenient places for the worms which may come down from the apples on the tree and also for those which may go up from the "windfalls." The bands should be put on in June or about the month after the blossoms have fallen, and they should be kept on until the fruit is gathered. They must be removed and examined every ten days until the latter part of August, when it will not be necessary to examine them again until late in the fall, except where more than two broods of the pest occur. All of the cocoons with their living contents must be destroyed at each examination; this can be done either by burning the cheap paper bands and putting on new ones each time, or, in the case of cloth bands, by putting them in hot water or by running them through a wringer. The necessity for this frequent examination of the bands arises from the fact that some of the worms will be changing to pupæ and the moths would soon escape, thus defeating the whole object of the use of the bands. All those who have expressed an opinion after using the bands extensively, state that the expense during the season need not exceed four cents per tree, or that they can be used with decided profit.

In 1887 Wickson carried on an experiment to get at the exact proportion between the worms on a tree and the number caught by bands during the season. He bandaged four hundred and fifty-seven apple and pear trees at the California Experiment Station, and caught only one thousand one hundred and eighty-eight worms while two thousand seven hundred and four fruits were found from which the worms had escaped; the bands had thus captured only forty-four per cent. of the worms. The trees were quite smooth, and only one band was used; doubtless better results would have been obtained by the use of two bands. However, forty-four per cent. is a good showing, and as Mr. Wickson well says: "the destruction of this proportion of fully fed and healthy larvæ must be considered very satisfactory;" and "it will be seen that this old method of treatment is still one of the most effective that can be employed." The next year a similar experiment was made at the Kansas Experiment Station, but in this case all of the trees were also sprayed with poisons, thus somewhat complicating matters. The record shows that the bands captured only about 8.5 per cent. (two hundred and thirty-eight thousand infested apples and only twenty thousand three hundred and ninety-eight insects) of the insects which had done the injury; one band was used, and it seems as though there must have been some conditions not mentioned in the record which might explain the great difference between these results and those obtained in California. Yet with even this small per cent. of worms captured it was considered that the bands could be used with profit in Kansas.

It is surprising how many of the worms can be captured sometimes under these bands. In 1873, Beal thus entrapped on two hundred and eleven trees bearing light crops, six thousand eight hundred and eighty-four of the insects during the season, the largest catch being one thousand four hundred and fifty on July 18, and the smallest, two hundred and ten on August 15.

Previous to the discovery of the spraying method for combating the codling moth, this banding system was the most successful method suggested,

and as the above facts show, it has been demonstrated that much can be done with bands to reduce the numbers of pest. Yet under the most favorable circumstances, apparently we cannot hope to capture more than half of the full-grown worms with the bands, and then not until they have done their destructive work. In short, with the bands we simply help to reduce the numbers of the succeeding generations of the insect, and thus at the best it is only a partial remedy. However, all who have tested it claim that the method can be practiced with profit, and it is evident that where there are two full broods or more of the insect we must devise something to supplement or take the place of the poison spray. Thus under such circumstances, doubtless the best method of combating the pest, so far as our present knowledge goes, would be to combine the band treatment with that of the poison spray, to be discussed next. Forbes arrived at the same conclusion in his experiments in Illinois in 1885 and 1886, as also did Popenoe, Marlatt, and Mason in their Kansas experiments in 1888; and experiments now in progress in Nebraska and New Mexico are along these lines.

### SPRAYING FOR THE CODLING MOTH.

Apparently the first suggestion to spray apple trees to check the codling moth was recorded in 1850 by Mr. Simpson of Massachusetts (Downing's Horticulturist, IV., 567). By placing a thin plate of beeswax over the "eyes" of a number of apples, he found that he saved them from attack by the apple worm. He then reasoned: "But the plan for practical purposes is to syringe the fruit with whitewash; this will fill the eye and thus prevent the moth from laying her egg."

About thirty years later the same idea seems to have been conceived by Doctor Hull, of Illinois. He recommended dusting air-slaked lime over the trees just after the blossoms fell, especially when the dew was on. In 1885, Forbes sprayed some apple trees eight times with fresh air-slaked lime mixed in water; the results indicated "the uselessness of this substance against the codling moth." In 1889, Gillette mixed some carbolic acid with plaster and threw this on the trees when the dew was on; two applications were made "with an apparent saving of thirty-four per cent. of the fruit that would have been wormy." He states that as it simply repels the moths from laying eggs and does not kill the insect, it could hardly be recommended even if it gave much better results.

*Spraying with poisons*—In 1872, LeBaron recommended fruit-growers to spray their trees with paris green to check the canker worms, and this method was soon adopted by many orchardists, some of them using white arsenic instead of paris green. In 1878, a practical fruitgrower accidentally discovered that when he sprayed his trees with paris green, he "not only rid the orchard of canker worms, but that the apples on the sprayed part were much less eaten by codling moths." *

*This fact seems to have been first discovered by Mr. E. P. Haynes, then living near Hess Road, Niagara County, New York. Mr. J. S. Woodward had advised him to use the poison for the canker worms, and in January, 1879, this discovery was reported to the meeting of the Western New York Horticultural Society by Mr. Woodward. It seems that the Hon. J. M. Dixon, and others, had also used white arsenic and paris green for canker worms in Iowa as early as 1875, but we can find no indications in the contemporaneous horticultural literature that Mr. Dixon realized he had at the same time checked the codling moth until 1880 (Trans. Iowa Hort. Soc.), or after Mr. Woodward had reported his success and it had been confirmed by the careful experiments of Cook in Michigan. It thus seems that to Mr. Haynes and Mr. Woodward belong the credit of this pioneer work in the discovery of what has proved to be the most successful method of combating the pest yet devised.

The first careful experiments by an entomologist with the poison spray were made in Michigan in 1880 by Cook, who had learned through Mr. Woodward of its successful use in Western New York. Cook sprayed twice with london purple and reported the following results in December of the same year: "The trees were loaded with fruit, but careful examination, made August 19, discovered not a single injured apple. Other apple trees, only a few rods distant, which were not treated with the poisonous liquid, are bearing fruit one-fourth to one-half of which is wormy." Notices of the successful use of the poison spray appeared in most of the leading agricultural papers, yet comparatively few adopted the method for the destruction of the codling moth during the next few years. Entomologists were somewhat afraid to recommend it, and orchardists seemed to hesitate in applying poison for this pest, although it was quite freely used for canker worms. A very few of the most progressive men adopted the method, and with apparently successful results.

In 1885 and 1886 Forbes and Goff made careful and extensive experiments with poison sprays, and the results indicated that at least seventy per cent. of the loss commonly suffered by the fruitgrower from the ravages of the codling moth could be prevented by thoroughly applying paris green once or twice in the spring. Similar results were obtained in California by Wickson in 1887. After the establishment of the State Experiment Stations in 1888, a new impetus was given to the adoption of the arsenical sprays, for nearly every station, sooner or later, reported the results of careful and successful spraying experiments against the codling moth. Not only has the practicability and effectiveness of the poison spray been demonstrated during the past ten years by the most carefully conducted experiments at nearly every experiment station in the United States, but the thousands of practical fruitgrowers who have thoroughly tried it are unanimous in their testimony that from fifty to even ninety per cent., in some cases, of the fruit that would otherwise be ruined by the insect can be saved at a comparatively slight expense. To insure success it is necessary to understand some of the essential facts in regard to the "whys and wherefores" of the operation which have been brought out at one time and another by the various experimenters during the past ten years.

*What poison to use*—Many comparative experiments have been made with the different arsenical poisons (paris green, london purple, white arsenic, arsenite of lead, etc.) to determine which is the most effective against the codling moth. In nearly every case the recorded results show a decided advantage in favor of paris green over all other poisons. At the present time hundreds of tons of it are used in the United States in combating the codling moth alone. It is less variable in its composition than london purple, and the latter is more liable to injure the foliage, but its cheapness and lightness cause many to use it in preference to paris green.*

Paris green should be used at the rate of one pound in from one hundred and sixty to two hundred gallons of water, or it can be used even a little stronger when mixed with the fungicide, bordeaux mixture. Careful ex-

*A "Zoektein Poison" was tested by Goff in 1888 and 1889, and "Climax Insect Poison" in Kansas in 1888, but neither these nor other poisons which have been tested have proved equal to paris green in effectiveness.

periments by Lodeman, Craig, and others have demonstrated that the poison is just as effective against the codling moth when used in combination with the fungicide as when used alone. When used alone there should be added to the paris green, but more especially to london purple, about twice as much freshly-slaked lime, to prevent any caustic action on the foliage resulting from the presence of soluble arsenic in the poisons: the lime already in the bordeaux mixture does this. It is therefore now a common practice among fruitgrowers to use the poison (for the codling moth) in combination with the bordeaux mixture (for the apple scab fungus), thus "killing two birds with one stone." In mixing paris green or london purple it is always best to first wet it up in a small quantity of water, making a sort of thin paste: if the dry poison is thrown directly into a large quantity of water it can not be mixed so quickly nor as satisfactorily.

*When to spray for the codling moth.*—The commonly accepted notion that the eggs of the insect were laid in or on the calyx of the fruit soon after the blossom fell, and the fact that a large percentage of the worms enter at this point, led to the recommendation to spray just after the blossoms fell. The experience of those who have sprayed has confirmed this conclusion, and it is now the universal practice to try and make the first application at this time. As Mr. Lodeman has put it: "The falling of the apple blossoms is the signal for the use of arsenites in the destruction of the codling moth." Our observations would indicate that a safe rule will be to spray the fruit at any time within a week after the blossoms fall; if it rains within a few days repeat the spray at once. The reason why and the great importance of spraying at this time is discussed under the next heading. Where there are both early and late varieties in an orchard it may be necessary to spray some trees before others: but usually there is not enough difference in time between the dropping of the blossoms from late and early varieties so but what all trees can be sprayed the same day. Although experimenters demonstrated that it was necessary to spray at this time to secure the best results, yet but few really understood the "why" of it: that is, just how it did or could affect the insect when applied at this time.

*How the poison affects the codling moth.*—Those who critically examine the literature, will be surprised to find how few definite statements there are regarding this very important phase of the question of combating this insect. It seems to have been the current notion for some time that the poison spray not only killed some of the insects, but that it also acted as a preventive in some way. It was in consequence of the repeated requests of Mr. Lodeman for information on this point that we began studying this old enemy, about which most of us have thought there was nothing new to be learned. We were surprised to find several times that our observations would not agree with the stereotyped notions regarding the life and habits of the insect at the time when fruitgrowers were spraying to kill it. Our first surprise was to find that the moths did not begin to emerge in considerable numbers until several days after the blossoms had fallen, and consequently we were unable to find any eggs until the blossoms had been off for a week or more.

Meanwhile, we had been watching the development of the young fruit, and had seen something of great importance to fruitgrowers, and which

seems to have escaped the notice of most experimenters; we have seen no mention of it except by Gillette and Munson. Just after the petals fell, we found the blossom ends of both apples and pears in the condition shown in Fig. 145; that is, the calyx lobes were spread widely open, forming a saucer-like cavity. As several complaints had reached us that the codling moth was not so easily reached on pears as on apples, we watched the developing pears also. The fruit at the left in Fig. 145 is a pear, and the only difference we could see at the time between it and an apple was that the latter was covered with a coating of fine hairs. At the time we theorized that possibly the paris green would stick to these "fuzzy" apples better than to the smooth pears, and the worms thus be more liable to get some of the poison on the apple, but this theory was soon exploded by further observations. About a week after the petals fell, we found that the blossom ends of apples and pears looked like those shown in Fig. 146; the center fruit is a pear. The calyx lobes on the apples had begun to draw together, and within the next few days the apples presented the appearance shown at *a* and *b* in Fig. 131: that is, the calyx lobes had drawn completely together, forming a tight cover over the calyx cavity. In the case of pears, however, the calyx lobes drew together very little. How this fact may affect the effectiveness of the poison spray for the insect on pears, will be discussed later. On most varieties of apples we found the calyx cavity closed within two weeks after the petals fell. Mr. Card found it closed in about ten days in Nebraska in 1897, but in the case of some varieties of apples, it never closed. Munson records that the calyx lobes on the Baldwin closed in about two weeks. The time doubtless varies a few days with different varieties.

Now, of what importance to the fruitgrower are these facts regarding the closing of the calyx lobes? Anticipating a little, it means that the closing of the calyx lobes is the signal that it is too late to get in your most effective blow against the codling moth with a poison spray.

Returning to our observations upon the insect, we found no eggs until the calyx lobes had closed, or nearly so, as shown at *a* and *b* in Fig. 131. And as the worms would not hatch until a week later, we were in a quandary to explain how a paris-green spray, applied according to the prescribed rule "of just after the blossoms have fallen," could possibly affect a worm appearing on the apple ten days or two weeks later. Our observations on the development of the young fruit, as just described, led us to theorize that the poison must have lodged in the open calyx cup (see Fig. 145) and, no rain intervening to wash it out, remained there while nature proceeded to draw a protecting roof over it (see Fig. 146) and finally left it securely hidden in the calyx cavity. Here it was found by a young apple worm a week or so later.

We soon found, as have other observers, that from seventy-five to eighty-five per cent. of the worms which hatch in the spring enter the apples through the blossom end; and we found also that these young worms got their first, and several subsequent meals, in this calyx cavity. It then only remained to prove the possibility of there being poison therein, which had been left there when the trees were sprayed two weeks before. Fortunately, about the time the worms were hatching, we found some apples which had been sprayed with paris green and bordeaux mixture just after the blossoms fell. A careful examination of the calyx cavity with a lens revealed particles of a bluish color. Were these particles of bordeaux mixture with their attendant bits of poison? Only the chemist could tell us. We at once carefully removed the calyx lobes and surrounding skin from about fifty of these apples and then submitted only that portion of the apples containing the calyx cup to our chemist, Mr. Cavanaugh. He soon reported traces of

145.—Just right to spray. A pear and two apples from which the petals have recently fallen. Note that the calyx lobes are widely spread.

146.—Almost too late to spray apples effectively. Note that the calyx lobes are drawn nearly together on the two apples, while on the pear in the center, the calyx cavity is open.

arsenic. The quantity found was scarcely enough to weigh, and it seemed as though it were not enough to kill the little apple worms. But when one remembers that only four or five gallons of the spray are usually applied to a whole tree, and when this is divided up among the millions of leaves and the thousands of apples on that tree, it is easy to see that the amount of arsenic which a single fruit would get, or even fifty of them, would be exceedingly small. Would it be enough to kill the young apple worms? Careful experiments have shown that it takes much less poison to kill caterpillars when they are small; and as the young apple worms are scarcely a sixteenth of an inch in length when they begin feeding in the calyx cavity, it would take only an infinitesimally small amount of arsenic to kill them.*

The above facts and observations lead us to believe that in applying a poisonous spray soon after the blossoms fall, we deposit some arsenic in the calyx cavity, where nature kindly takes care of it for us until ten days or two weeks later, when the little apple worm includes it in the menu of his first few meals. Furthermore, the poisoning of these young worms which enter the developing fruit in the spring, seems to be the only way and only time that the insect is or can be the most successfully reached with the spray; as the worms sometimes eat through into the calyx cavity from the outside at the base of the lobes, and as some of the poison often lodges here, possibly a few of them get enough poison to kill them at this point. Not enough of the spray can be made to stay on the surface of the fruits then, or at any subsequent time to reach one in a hundred of the worms which enter elsewhere than at the blossom end. Put in another way, the above facts mean that we can hope to reach with a poison spray only those apple worms which enter the blossom ends of the forming fruits in the spring. To do this, the application must be made soon after the blossoms fall, when the calyx is open, as shown in Fig. 145. If we wait a few days until the fruit has reached the condition shown in Fig. 146, or still later as at *a* and *b* in Fig. 131, it will be too late. We can conceive of no possible way in which a majority of the fifteen or twenty per cent. of the worms which enter the fruit at some other point in the spring, and all of the worms of the subsequent broods, can be effectively reached with the poison spray.

Thus, while the spraying method is very effective, it can never prove a perfect penacea, especially where there are two full broods or more of the insect in a season. However, it is a great improvement over the old banding method, for with the spray we kill the worms before they fairly begin their destructive work, thus saving the fruit they would otherwise ruin with an ugly worm hole. Our observations indicate that the little worms do no feeding on the outside of the fruit except just enough to make a tiny entrance hole into the flesh or into the calyx cavity. If it were not for their habit of feeding in this blossom cavity for a few days, it is doubtful if spraying would

* Munson has figured out how much poison would be liable to stay on one apple, allowing two sprayings of two gallons each to a tree. His figures show that the amount of poison per fruit would be less than three one-thousandths of a grain.

Others have made chemical analyses of the blossom ends of apples, and report no traces of arsenic, but their material was not taken until several weeks after the spraying was done (and it may not have been done when the calyx cup was open), hence could be of little value to determine the point in question.

be nearly so effective as it is. It is thus a remarkable fact how much of our success with a poison spray depends upon this habit of the little worms.*

*Never spray a fruit tree when it is in blossom*—You can reach the insect and fungous enemies just as effectively, and in some cases more so, either just before or just after the trees blossom.

*How many applications to make*—As has just been shown under a preceding topic, it is necessary to success to get a dose of poison into the blossom end of the young fruit soon after the petals fall, and before the calyx lobes have drawn together. If no rains occur between the time of spraying and the closing of the calyx lobes, then this one application will be just as effective, we believe, if it is thoroughly done, as half a dozen later applications. The sole aim of the fruitgrower should be to have a dose of paris green in that calyx cup when it is covered by nature. If rains wash out one application, then spray again if there be still time before the blossom cavity is covered. Usually the recommendation is to spray trees twice, once just after the petals fall and again in a week or ten days, to catch the last worms which hatch.

Many extensive experiments have been made to determine the number of applications it is necessary or profitable to make. In 1885, Forbes made seven and eight applications, and the next year only one and two. His results were equally as satisfactory from the lesser number of sprayings. This is also the conclusion reached by Lodeman and others who have made comparative tests. These results are what we should expect from the life-history and habits of the insect. When the second brood of the worms hatch, the calyx cavity is securely closed and the apples have turned down, so there is scarcely any chance to lodge the poison where the little worms would be liable to get it before they get into the fruit out of harm's way. Yet some experiments in Oregon indicate that a few of the worms of these later broods can be reached with the spray, and apparently enough of them to lead the experimenter to conclude that even six or seven applications can be made with profit. However, it is the unanimous conclusion of experimenters here in the eastern portion of the United States, where there are only two broods or less of the insect in a year, that two applications are sufficient, one just after the petals fall and a second a week later. No definite date can be set for spraying for the pest, as the falling of the blossoms will vary from year to year in the same orchard.

The important thing for the fruitgrower to do is to watch the blossoming of his trees and the developing of the young fruit, and not depend on anything or anybody else. Simply see to it that there is a good dose of poison

*We have never found any dead worms in the calyx cavity, and thus have no absolute proof that they are killed by the poison there, but Munson has recorded an experiment in Maine which strongly indicates that this is the case. He found that out of three hundred and forty-six wormy fruits borne on sprayed trees only one hundred and thirty-three had been entered by the worms at the calyx, while two hundred and thirteen worms had entered at the side or base; and out of four hundred and forty-nine wormy fruits on unsprayed trees, two hundred and fifty-two were entered at the calyx, while only one hundred and ninety-seven worms entered at the side or base. Thus the relative number entering the calyx was more than doubled in the case of the unsprayed tree. "The only plausible explanation would seem to be that the poison lodging in the calyx, had destroyed the larvæ attempting to enter at that end, while those entering the side or base escaped. The larvæ of the second brood were also exempt."

put into each blossom end and that it is not washed out by rains before nature gets it protected with the closed calyx lobes.

*How to spray for codling moth*—Thousands of fruitgrowers annually go through the operation of spraying their orchards, and yet many of them simply waste their time and money, for they only half do it. Every one who sprays, or is thinking about doing so, should read and reread Professor Bailey's "Notions About the Spraying of Trees."

As most of those who have sprayed for this insect have not thoroughly understood the necessity for filling the blossom end with the poison, there is but little definite evidence as to just how this can best be done. Mr. Card, in Nebraska, has recorded the following pertinent suggestions on this point: "By following the sprayer, I found that ordinarily we do not get the calyx thoroughly drenched. For this reason the spray was made coarser than heretofore, and this seemed to work better, particularly when applied with considerable force. It appeared easier to get poison into the cavity when lobes were wide open (see Fig. 145) than when they had begun to close (see Fig. 146), making a vase-formed receptacle. The leaves increase in size very rapidly after the blossoms fall, so, on this account, the sooner the spraying is done the more thorough it is likely to be. Where there is no danger that the poison would be washed out by rains, the best time to apply it would be immediately after the blossoms fall. The later the poison is applied while the calyx is still open the better."

*The expense, or will it pay to spray for the codling moth*—Your neighbor who has been spraying his orchard for a year or more can the most effectively answer this question for you. It not only pays to spray thoroughly, but it is a positive necessity in many cases. The cost per tree is but a trifling matter and will not exceed from five to ten cents for the season, depending upon facilities, rains, etc.

It will be necessary to spray for the codling moth every year that there is a setting of fruit, for several reasons. Usually there are less enterprising neighbors who do not spray, and who thus breed a crop of the moths annually, some of which will find their way into your orchard. The insect breeds readily in wild haws, pears, and some other fruits, so that even when there are no apples in a locality some years, the codling moth does not lack for food. And especially must one remember that we can not hope to reach with the poison spray the fifteen or twenty per cent. or more of the worms which do not enter the fruit at the blossom end, and these are sufficient to develop a large crop for the next season, where there are two or more broods of the insect in a year.

*Is there any danger of poisoning the fruit with the spray, or the stock pastured in sprayed orchards?—No.* For several years after the introduction of spraying for the codling moth, this notion prevented its coming into general use. But today one scarcely ever hears the question considered seriously. In 1889, Cook made some experiments in Michigan which effectually settled the question that there is no danger from pasturing stock in the sprayed orchards.

He drenched some apple trees with london purple, used twice as strong as recommended. All the poison which dripped off was caught on a paper, and the amount of arsenic on this paper then determined by the chemist. In one case, it amounted to two-fifths of a grain, and in another to two and one-fifth grains. Although these analyses showed that there was little or no danger, the matter was more fully tested by thoroughly spraying other trees under which was growing some bright and tender grass. All of the grass was cut close to the ground and Professor Cook fed it to his horse; and no injury resulted. The experiment was repeated later with the same result. Next three sheep were kept till hungry and then put in a pen made under another tree which had just been sprayed. All of the grass was eaten with no injurious results. This experiment was twice repeated with the same result. Thus practical experiments confirmed the conclusions of the chemist.

As no poison is usually sprayed on the fruit after it is half grown, the rain and wind would naturally remove the last particle of it before the fruit was picked. Chemical analyses have shown that there was not the slightest trace of arsenic on the mature apples which had been sprayed several times when they were small.

*Why the spray may not be so effective on pears.* Several fruitgrowers have asked us to explain why they were unable to control the codling moth on pears as effectively as they do on apples. We can only offer the following suggestions on this point: Our observations on the young pears after the blossoms fall show that the calyx lobes never draw together as they do on most varieties of apples (see Figs. 145 and 146). While it would thus be just as easy to lodge some poison in the blossom end of the pears, the fact that the calyx cavity remains open or unprotected would permit the poison to be easily washed out by rains or blown out by winds. Whether the recently-hatched apple worm has similar habits when born on a pear as it does on an apple, we can not say from observation. Possibly, however, the fact that the calyx cavity is open, may cause the worms to enter the fruit at once, thus taking but few if any meals in the blossom end. Thus the fact that it will doubtless be more difficult to keep a dose of poison on pears, owing to the open calyx, may partially explain why it may be more difficult to control the insect on this fruit.

In 1874, Riley recorded that experiments in Illinois had shown that pears were mostly injured by the second brood of the apple worms. Washburn recently reached a similar conclusion from his observations in Oregon. As it has been shown that we can reach but few of the worms of the second brood on apples with a poison spray, it is evident that a similar treatment on pears would have little effect, providing that most of the injury to pears is done by the second brood of worms. Perhaps we have been spraying too early for the insect on pears. Wherever it does serious injury to pears, it would be well to make some careful experiments with the poison sprays.

Briefly stated, no panacea for the codling moth has yet been found, but by thorough work by a paris-green spray, we can often save at least seventy-five per cent. of the apples that would otherwise be ruined by the worms. Where more than two broods of the insect occur during the season, as in Kansas, Nebraska, Oregon, New Mexico, and neighboring localities in the west, and in the south, the poison spray is not so effective, for although

seventy-five per cent. of the first brood of worms may be killed with the spray, the few worms left will form a sufficient nucleus for a large and very destructive second or third brood: in these localities the best that can be advised at present is to supplement the poison spray with the old banding system.

To use the poison spray the most effectively, one must understand that it is necessary to fill the blossom end of each apple with poison within a week after the blossoms fall, for this is where the little apple worm gets its first few meals, and it is practically our only chance to kill it with a spray. Watch the developing fruit after the petals fall, and be sure to apply the poison before the calyx lobes close (as at *a* and *b* in Fig. 131), for while the falling of the blossoms is the signal to begin spraying, the closing of these calyx lobes a week or two later is the signal to stop spraying.

While we thus have no new methods to offer, and doubt if anything better than the poison spray will be found for combating this insect, we believe that a better understanding of the "whys and wherefores" of the methods already in use will insure still greater success with them.

# THE APPLE-PLANT LOUSE.

(*Aphis mali* Koch).

By John B. Smith, Sc.D.

For several years past an increasing number of complaints has been received of injury caused by plant lice on apple trees, young stock suffering most severely, but older, bearing trees being by no means exempt. The insects appear with the foliage, and where they are at all numerous the leaves begin to curl, and growth is checked early in summer. The aphids excrete a sweet, sticky liquid, called "honey dew," in great abundance, and on this a black soot fungus develops, which chokes the leaves, causing them to become dry, turn brown, and sometimes to drop. Often the tips of the shoots are killed, though more frequently they are stunted, and the young tree makes no satisfactory growth, barely maintaining itself in many cases. On bearing trees the young fruit is checked in development, becomes sooty, crippled, and never ripens properly.

The injury is often severe, and seems to be steadily increasing. Ten years ago the insects were rarely seen in large numbers; in 1898 and 1899 the damage caused by them in some orchards exceeded that of all other insects combined.

Not all varieties of apples are equally susceptible to attack; but as no notes were made until so late as to make them incomplete, no definite information on this point can be given at this time.

In the published accounts of the apple louse, it is said that the eggs are on the trees during the winter, hidden in crevices, laid at the base of the buds or wherever else they can be suitably placed. From these eggs come little green lice or aphids in early spring, and these develop into what are known as "stem-mothers"—wingless and sexless forms that produce living young.

The young from these "stem-mothers" become winged in due time, and migrate to wheat or other grasses, where they propagate during the summer. In fall another set of winged forms—"return migrants"—are developed, and from these come the sexed individuals. They copulate and the female lays eggs, thus completing the life-history.

There is no doubt that there is a species that has such a life-cycle, but there is another that has been confused with it, and a careful reading of the various accounts shows that observers have not discriminated between the two—as when it was suggested that both winged and wingless males occur in the seme species.

FIG. 1.—Tip of an apple twig infested by plant lice.

In 1897, and again in 1898, I made certain that the species that was injuring the apple trees in our state bred on them throughout the season, and that there was no alternate food plant; therefore no true "migrant" or "return migrant."

Tree No. 33 in the experiment orchard became very lousy in 1898, and in the fall of that year it was observed that eggs were being deposited in large numbers. I decided then to begin a series of observations on the specimens developing on this one tree. Both sexes were present in numbers November 1, and already many eggs had been laid. Copulation was frequently observed, and a number of pairs were preserved for study. Both sexes are wingless, and at no time did I notice any winged males. The females are of a uniform velvety green, sluggish in motion, and rather more than one-twentieth of an inch in length. The males are smaller, much more active, and a dull yellow-green in color. The eggs are large in proportion to the insects, dark-green in color when laid, becoming black in two or three days. They are regular, rather elongate-oval in shape, and smooth, shining. Oviposition continued until near the end of November, and at Moorestown I found specimens yet laying eggs in early December.

To preserve a considerable number of the eggs, tree No. 33 was given comparatively little and irregular pruning. After the tree started in the spring of 1899, and aphids began to develop, observations were made at first almost daily, and specimens were preserved at frequent intervals throughout the season. Nearly fifty vials of shoots, with the insects in all stages, in either alcohol or formalin, were accumulated, and from these nearly one hundred and fifty slides, containing upward of one thousand examples, were mounted. All of these were carefully studied in connection with the notes made during the summer, to bring out the complete life-history. Unfortunately, it was assumed that all the summer broods were alike, and during that period specimens were not preserved as often as earlier or later in the season. I am not certain, therefore, that there are not more generations than I have given, and there may be even more forms than I discovered. To make certain of my species, I submitted mounted specimens to Dr. L. O. Howard, Entomologist of the United States Department of Agriculture, and he promptly transmitted to me the report of his assistant, Mr. Theo. Pergande, who knows plant lice at least as well as any other student in America. Mr. Pergande says that the specimens are undoubtedly *Aphis mali* Koch, and may be the species called so by Fabricius. It is not the species called *Aphis mali* by Fitch, Thomas, Weed, and other American authors. Therefore, it must not be assumed that the accounts given by them are erroneous because they do not agree with that given here. They simply apply to another species, and we can no longer speak generally of "the" apple louse. The term "apple-plant louse" is suggested for the species here described, because it has no alternate food plant; the other form might be called the "apple and wheat louse."

### LIFE-CYCLE.

The earliest time known to me for the appearance of this insect is March 28, when I received from Marlton, Burlington County, apple buds already covered with specimens. The date of the first coming may be generally

considered as coincident with the opening of the apple-leaf buds.

On the experiment tree the buds began to start April 15, and on that day I found two plant lice, just from the egg, feeding on a bud that had scarcely more than broken the scaly covering; in other words, before there was even a sign of foliage. On the sixteenth many more specimens were seen, and on the seventeenth almost every bud had from two to ten plant lice sucking its juices. To get a definite basis for my record as to length of time required for the development of this series, I cleaned the insects from every bud on the eighteenth, brushing them up with a hair pencil into an alcohol vial.

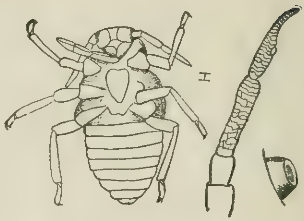

Fig. 3—Apple plant louse, just from egg; antenna and honey tube more enlarged.

April 20 there were no lice over two days old on the tree, and the opening buds on some of the twigs were again completely covered. A few cast skins were seen, indicating that some specimens had already molted once. The larva just from the egg is an awkward creature, with rather long, fleshy legs, that seem to be in its way rather than helpful, and short, stout antennæ or feelers. These feelers are made up of four joints: Two short and thick at the base; the third more slender, almost twice as long as the others combined; the fourth tapering to tip, shorter than the third, and with a sensory pit at the thickest portion.

The sensory or sense pits on the antennæ of plant lice, to which frequent reference will be made in this account, are organs whose use is yet obscure to us. Judging by their structure they should serve as ears or organs of hearing, but this is by no means certain.

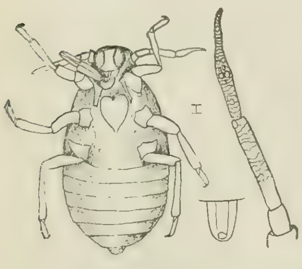

Fig. 4—Second stage of the larva; antenna and honey tube more enlarged.

The honey tubes are very small, little more than mere warts or tubercles, with round openings at the tips. This combination of a small honey tube and a feeler in which there is a single sensory pit on the terminal joint, is peculiar to this larva just from the egg; none of the later broods have it.

Two or three days after emerging from the egg the larva outgrows its skin and molts. It now appears in a new dress, almost one-half longer than it was before and considerably stouter. The legs seem to be proportionately shorter and less clumsy; but the insect is quite as little inclined to move about as it was before. The honey tubes are now much larger and quite obvious. They are as long as one segment of the abdomen, quite stout, and tapering a little to a rounded tip.

These honey tubes are peculiar structures, found only in the plant lice, and they serve a unique purpose in the history of some species. It is a common observation that wherever plant lice are abundant ants are likely to be found, and it is a usual conclusion that the ants feed upon the plant lice. As a matter of fact this is not so; the ants and the aphids are on the best of terms, and in many instances are useful to each other. The ants in such cases obtain from the plant lice droplets of honey

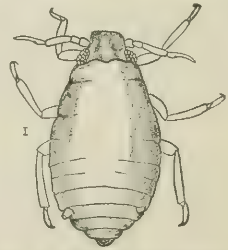

Fig. 5—Second stage from above; enlarged.

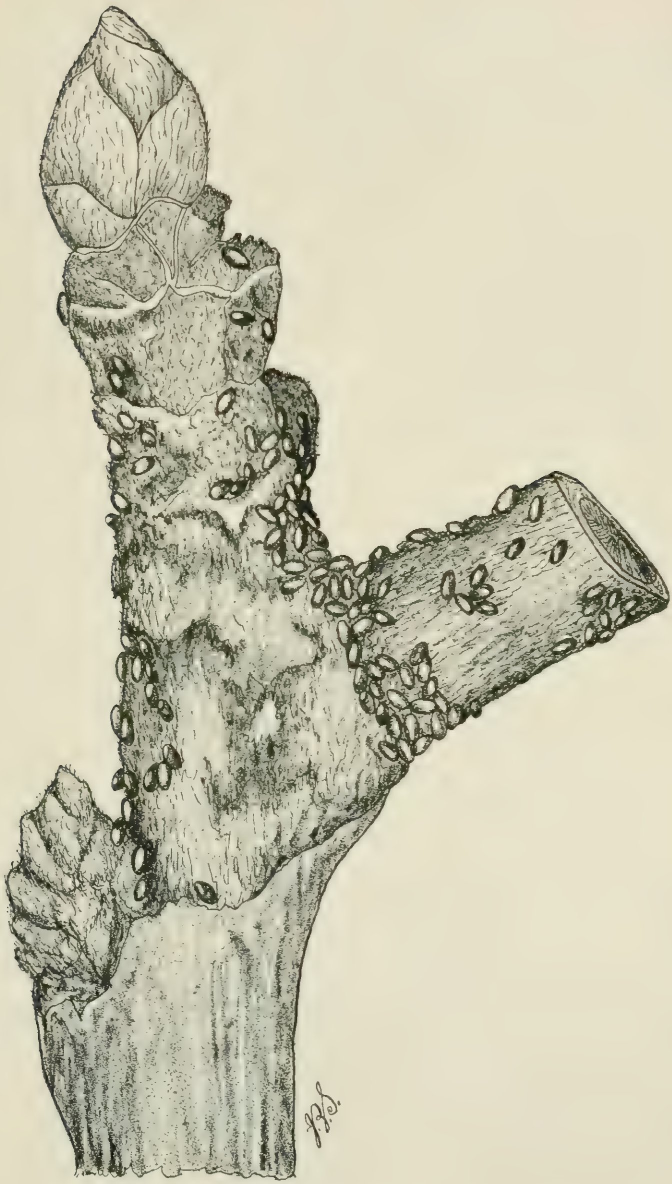

FIG. 2.—Eggs of apple plant louse: very much enlarged.

dew, of which they are very fond, and, in return, gather and care for the eggs of the aphids during the winter, colonizing the young in the spring on the proper plants. No such relations exist, however, in the present case.

Unlike most other insects, plant lice absorb more food than they can possibly assimilate. They are constantly engaged in pumping out plant juices, and what they cannot use is excreted, either in little droplets through the honey tubes or in minute jets through the anal opening. It is in this way that they cause the glazed or varnished appearance upon the leaves below them, and form the bed upon which the black soot fungus already mentioned finds its favorable opportunity to develop.


Fig. 6—Third stage of the larva; embryos becoming evident; enlarged.

To return to our plant louse which has just molted. It has yet the same number of joints in the antennæ, but these are now more slender, and there is a distinct sensory pit at the end of the third joint, while the single pit on the fourth joint has changed to a little group of three or four.

April 26, some specimens had molted a second time, and were now in their third stage, almost double their original size. The eyes, which in the earlier stages are composed of a few large, round ocelli, placed closely together, are now larger and composed of a greater number of smaller lenses. At the end of the body a little hairy process has become evident, and the third antennal joint shows an obvious tendency to divide into two parts. In the mounted specimens the forming young or embryos are now visible through the body wall.

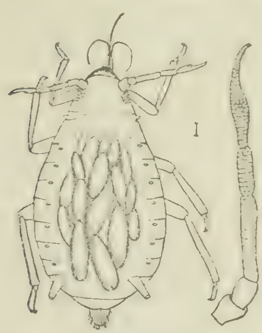


Fig. 7—Fourth stage of larva; the antennæ further enlarged.

April 28, the fourth stage was reached by the more advanced examples. They are now more oval and seem to be more fully distended, while the eyes are yet larger and more obvious, tending, indeed, to become a little pigmented. The antennæ are now five-jointed, a sensory pit is at the tip of the fourth, and a group of them is at the enlargment of the fifth joint. Now, also, the peculiar scaly surface of the aphid feeler becomes obvious, especially on the terminal two joints. Seen under the microscope, it appears as if the joints were irregularly shingled from tip to base, the shingles varying in length, breadth and form of the corners. This feature is best marked in the most fully-developed stages; but it is traceable even in the earliest, on the terminal joint at least.

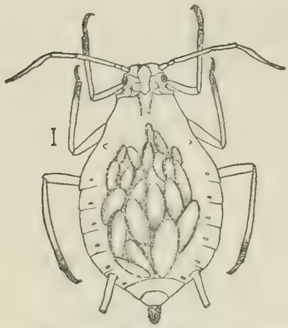

Fig. 8—Stem-mother: fifth stage from the egg; enlarged.

The honey tubes have changed to some extent. They are now longer than one body segment, taper a little to the tip, and are there squarely cut off. They are slender tubes or cylinders, rather than, as before, fleshy processes through which tubes are carried. The terminal segment is yet more prominent, and the embryos are seen to be well developed inside the body.

By April 30 all the eggs were hatched, and on May 2 no more larvæ in the first stage were noticed; all had molted at least once, and a large number were in the fifth stage ready to reproduce.

These "stem-mothers," as they are called, are about .08 of an inch long, bright green in color and almost pear-shaped. They have no wings nor traces of such organs, and are not sexually developed, i. e. they are neither males nor fully-developed females, but forms that reproduce their kind without sexual union. This is called parthenogenesis or, sometimes, agamic reproduction. It is a common occurrence among the plant lice, and accounts in part for their great powers of multiplication, every individual being capable of bearing young.

Fig. 9—Antenna, honey tube and tarsus of stem-mother; very much enlarged.

Though the body of this stem-mother is very large, the legs, antennæ and honey tubes are much more slender, all the parts being better defined. The eyes are now brown in color, the facets numerous and small, and the honey tubes exceed two body segments in length, being also brown. Except that they are longer and more slender, the feelers do not differ from those in the preceding stage. This is the only series of breeders in which the feelers have only five joints.

In this stage the tips of the tibiæ, or shanks, and the tarsi, or feet, are blackish, a little color character which is present in all the reproducing forms of this species and absent in all the larval stages. The last body segment has become developed into a dark-brown, tail-like process, and this is another feature of the adult stage in all the series.

May 3, the first young of the second brood were seen, and this draws attention to another peculiarity of these insects: they bring forth their young alive and ready at once to feed. For this reason we call them viviparous.

From the eighteenth of April, when the eggs hatched, to the third of May, when the specimens coming from the eggs first produced young, is a period of fifteen days, which may be assumed as the average length of time required for this first brood to come to maturity. But as egg-hatching did not cease until April 28, it would be May 13 before all the specimens had

reached that stage. It is also well to remember that I killed off everything that hatched prior to April 18; hence May 1 may be fairly assumed as the date when the first "stem-mother" in the latitude of New Brunswick is ready to propagate her kind. These periods are of importance because of their bearing on the problem of reducing injury.

Fig. 10 — Larva just born from stem-mother; first stage of second series; antenna and honey tube further enlarged.

The young that are born by the "stem-mother" differ quite markedly from those hatched from the eggs. The legs are longer, actually and in proportion; the honey tubes are as long or longer than a body segment; the antennæ are without any sense pits, and the beak is as long as the insect itself.

It is in place here to say that plant lice feed by puncturing the plant tissue and sucking the juices. They do not actually eat any part of the leaf or twig: hence arsenical poisons or any others that act through the stomach are useless. The mouth parts consist of a jointed beak in which there are four slender lancets, two of which are united for the greater part of their course. These minute lancets pierce the plant cells and absorb the sap: the cells dry, and, as the sucking on the leaves is done mostly from the under side, they curl and become deformed. Where the infestation is on a fruit spur the supply of nourishment for the forming apple is materially lessened, and often it drops. If it does not, full size is not attained, and the honey dew, with its accompanying soot fungus, is likely to cause deformation.

May 4, reproduction was general, and young lice were present in large numbers. The stem-mothers and their young now began to wander. The young did not at once fix near where they were born; many adults moved from twigs to the leaves, which were now well developed, and they were found even on the trunk and branches. Already some of those born on the third had molted, the first stage being, apparently, a very short one.

Fig. 11—Second stage of second series; antenna more enlarged.

In this second stage the beak is relatively shorter and the insect is more oval. The honey tubes exceed the body segments in length, and are thick cylinders, tapering a little from the base. The antennæ are now five-jointed, obscure sense pits being located on the fourth and fifth.

May 5, colonies of stem-mothers and their young were found everywhere on the leaves, usually from six to twelve young about a single mother, but in a few cases over twenty on a single leaf, around a single female. Now, as there had been no breeding before May 3, this means that from eight to ten young daily is about the capacity of these examples. Small wonder, then, that in some cases where three or four stem-mothers had populated a leaf this was already beginning to curl.

The third stage was found May 7, and on May 9 young of two types were present in abundance. In one, the pear-shape was well developed; in the other, the form was more oblong, head and throax were larger, and distinct shoulders indicated the formation of wing-pads, which could be, indeed, seen very clearly in the mounted specimens.

Here, then, is a divergence; some of the progeny from the stem-mothers tend to become like them, others are tending to the development of wings. Nothing was seen in either the first or second stage to indicate any such divergence.

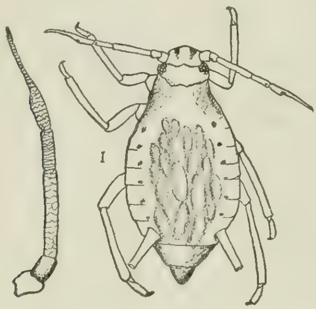

Fig. 12—Third stage of second series, which will remain wingless; antenna more enlarged.

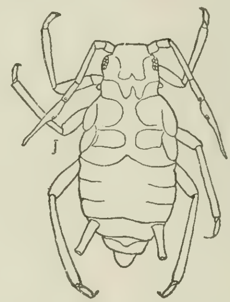

Fig. 13—Third stage of second series, which will become winged; enlarged.

In antennal and honey-tube structure these two forms are practically alike. The feelers are five-jointed, extend to the middle of the body when bent back, and have the sense pits at the end of the fourth and middle of the fifth joints. The honey tubes are equal to two body segments, are quite stout, just a little narrowed at the middle, and at the tip a trifle flared or enlarged.

In the wingless form the embryos are beginning to develop, and show clearly through the body wall, in the mounted specimens. In the other form no appearance of young could be discerned.

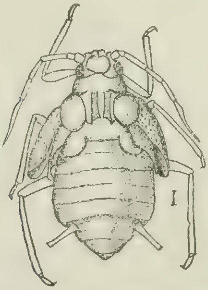

Fig. 14—Fourth stage of second series, winged type, the true pupa; enlarged.

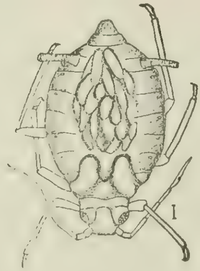

Fig. 15—Fourth stage of second series, wingless type; enlarged.

May 10, the fourth stage of both series was found. On the one hand, there is now a fully-developed pupa, with evident, uplifted wing-pads, distinct

head and prothorax, pigmented eyes and well-marked body segments; on the other, the form is yet more like that of the stem-mother, the head not well separated, the eyes much less marked, and the body segments scarcely distinguishable except at the edges. The embryos in this form are now much larger and more obvious. In both types of this stage the feelers are six-jointed, and much more evidently scaly. There is a little censory pit at the end of the fifth segment and a little group at the enlargement of the sixth segment. Here we have a radical departure from the first series, no form of which had more than five joints. The honey tubes are long and slender, almost or quite equal to three body segments, and the mouth or tip is a little flared. In the pupa the legs are longer and proportionally more slender than in the wingless type.

May 12, the fifth stage was found. There were now a few winged examples and a new series of wingless breeders, the number of stem-mothers having much decreased, though there were yet many of them present.

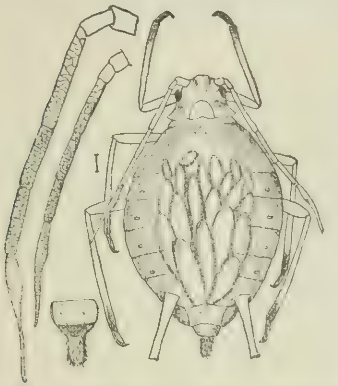

Fig. 16—Wingless agamic, viviparous female of second series, ready to reproduce; antennæ of this (the longer) and preceding (the shorter) stages and "tail," yet further enlarged.

It will be noted that this second series has come to maturity much more rapidly than the first brood, only nine days being required from birth to the reproductive stage, instead of fifteen. The number of molts or stages is the same, but each stage is much shorter.

May 15, there was a marked increase in the number of winged forms, and a new period was entered upon—that of migration or, more properly, flight to other trees. The winged forms require a day to become fully matured, and then most of them, if the day be at all quiet and sunny, fly from the place where they hatched, and, guided largely by the wind, they drift to other trees. So, while tree No. 33 was the only one that previous to this time was lousy, almost all the others in the experiment orchard were now becoming infested by the winged individuals developed on No. 33. While, for convenience, the term "migrant" may be used for the winged form of this species, its true application is to a type which flies to another or alternate food plant.

The condition of affairs found at New Brunswick May 15 existed at Moorestown, Burlington County, at least five days previously, for I received, May 10, some shoots absolutely crowded with winged forms and with what was probably, in part at least, their progeny. So it is likely that in the extreme southern counties May 5 will find winged migrants, while north of New Brunswick they will appear a few days later than the fifteenth.

These winged aphids are about seven-hundredths of an inch in length, but with the wings expanded measure almost or quite twenty-five hundredths of an inch. They are green in color, but the head and the raised portions of the thoracic disc are black. The legs are long and slender, the

knees, as well as the tips of the shanks and the feet, blackish. The honey tubes are long, slender and also black, as is the tail.

The antennæ are almost as long as the insect itself, and are six-jointed. The third joint—the first of the long joints—has a series of from six to ten sensory pits, arranged in a line on the outer side. Though it is a somewhat variable matter, seven pits are normal. In a general way, there is a little group of three near the tip, another group of three near the middle, and a single pit near the base. One of the pits near the tip sometimes becomes multiplied into two or three, or one of them may drop out; so, while there may be an actual difference in the number of pits, the general arrangement and appearance remain the same. The single pit at the end of the fifth joint and the little group at the enlargement of the sixth remain as in the other stages.

The head in this form is distinct from the other segments, and there is a pair of ocelli, one on each side, close to the compound eye.

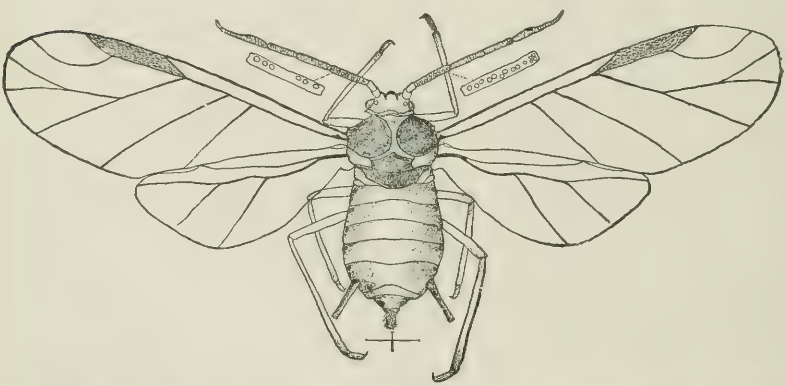

Fig. 17—Winged apple plant louse, much enlarged; single joints showing sensory pits, yet more enlarged.

The corresponding stage of the wingless type resembles the stem-mother, except in size. It is never more than six-huudredths of an inch in length, and seems proportionately less obese. The antennæ are six-jointed, there is a sensory pit at the end of the fifth joint, and a group of very small pittings on the sixth. The honey tubes are proportionately much larger than in the stem-mother, as is the tail. The legs are slender, and have the usual darkening of the tips of the tibiæ and of the tarsi.

May 16, the stem-mothers had practically disappeared, and their wingless descendants had begun to bring forth young. No positive observations

have been made on this particular point; but from the notes and from the preserved specimens, it is probable that the life of the individual stem-mother is short, that she does not continue reproduction more than five days, and that the progeny of a single individual does not reach fifty.

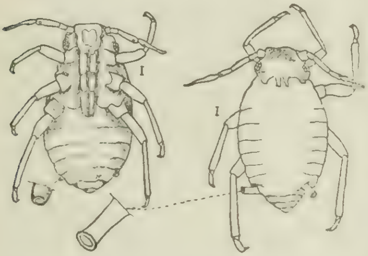

Fig. 18—Larva just hatched from winged form (under side), and second stage of same (upper side); honey tubes yet further enlarged.

May 21, 25, and June 4, leaves containing winged migrants surrounded by their progeny were picked from trees other than No. 33, and these were preserved. It was, unfortunately, assumed that the descendants of these migrants would be identical with those of the wingless forms, because at the field examination they looked so; therefore, they were not followed beyond the fourth stage, and no specimens were gathered from any tree other than No. 33 after June 4. Nor have I any notes as to the number of young produced by this form.

It may be added that of the descendants of the stem-mother fully three-fourths become winged, practically all of which leave the tree on which they hatched. On a large tree it is at least very likely that many would reach only another portion of it; but in the case of a tree like the one under observation, I doubt if any of those that start from ever return to it.

Fig. 19—Third stage from winged form; enlarged.

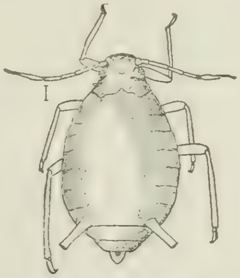

Fig. 20—Fourth stage from winged form; enlarged.

The larva produced by the winged form—which is both parthenogenetic and viviparous, exactly as is the corresponding wingless form—resembles that hatched from the egg, save that the honey tubes are a little longer and that there is a sensory pit at the tip of the third joint. The second stage has the honey tubes stout, longer than a body segment, a little flared at tip. The antennæ are now five-jointed, and have a single sensory pit at the tip of the fourth and no obvious pittings at the enlargement of the fifth joints.

The third stage does not differ, except in size, from the second, though now, as usual, the developing embryos become visible through the body wall. In the fourth stage the antennæ are six-jointed, the single sensory pit being at the tip of the fifth joint. The honey tubes are as long as two body segments, and taper a little toward the tip, which is somewhat flared. In this stage there is no very obvious difference when compared with the same stage from the wingless form. It is to be noted that none of the descendants of these winged forms showed any traces of forming wing-pads, but I am not prepared to say that none are now developed.

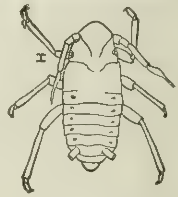

Fig. 21 — Larva of third series, just born from wingless and agamic female of second series; enlarged.

To avoid all chance of getting examples of the second series, descendants of the wingless viviparous forms, that began to mature May 12, were not examined until May 17. These larvæ have stout honey tubes about equal to a body segment in length, four-jointed antennæ without sensory pits, and in other particulars resemble the previous series. In the second stage the honey tubes are a little longer, the antennæ are five-jointed, yet without sensory pits, and the form is a long oval. The third stage shows the usual increase in size, and in the fourth stage the antennæ are six-jointed, resembling the descendants of the winged form, except that there is no sensory pit in the fifth antennal joint.

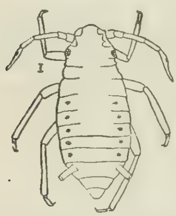

Fig. 22–Second stage of larve of third series; enlarged.

June 6, a new series of winged forms was making its appearance, and there was a very general occurrence of a third series of wingless parthenogenetic, viviparous females. This type has been present for some days, but I preferred making certain of its being actually distinct before mounting specimens. Matters were now becoming very decidedly mixed, and while the second series of wingless forms were almost gone, some yet remained, and from them were born plenty of larvæ that corresponded in age with those from

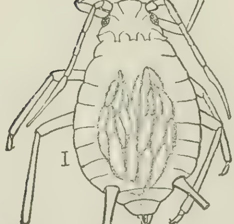

Fig. 23 — Fourth stage of larva of third series; enlarged.

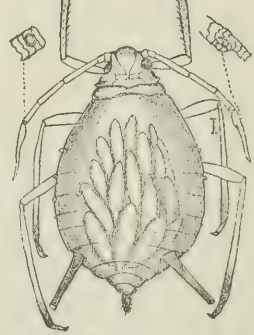

Fig. 24—Wingless, parthenogenetic, viviparous female of the third series; sensory pits of the antenna yet further enlarged.

the third series. It is certain that of the descendants of the second series a considerable proportion become winged, but not nearly so many as in the first series. There is no difference between the winged forms now maturing and those produced in May.

The parthenogenetic wingless females of the third series are similar to those of the second series, but the honey tubes are shorter, the tail is longer and more slender, and it does not quite reach the same size. The antennæ are six-jointed, there is a sensory pit at the end of the fifth joint, and a group of four, all very distinct, is on the sixth joint. Day after day, until June 13, these forms increased in number, and at that time those of the second series had disappeared. It was hopeless now to attempt to follow out individual series, and all that could be done was to recognize different types prevailing at different periods. It was not realized that there was any notable difference except, possibly, in size, otherwise it would have been easy to colonize individuals of each brood upon other trees previously freed of all other types. So it is not possible to speak definitely of the length of time required for an individual to come to maturity, but I am inclined to believe that none develop so quickly as do those of the second series. In fact, judging from the preserved specimens and from the field notes, new series appeared at intervals of about twenty days.

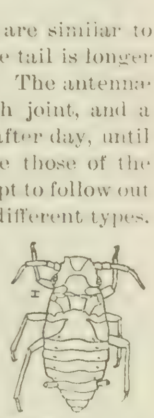
Fig. 25—Larva of fourth series just born from wingless and agamic female of third series; enlarged.

June 13, none of the second series remaining, the newly-born larvæ were all from the third series. They had short, barrel-shaped honey tubes, four-jointed antennæ without sensory pits, and did not offer other characters differentiating them from previous forms. In the second stage the honey tubes are equal to two body segments in length, taper rather evenly to the tip, and are squarely cut off. The antennæ are five-jointed and there are no sensory pits. The third stage is somewhat more oval, the honey tubes are yet stout and flare a little at the tip. The fourth stage was not identified with certainty.

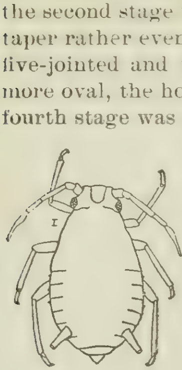
Fig. 26—Second stage of larva of fourth series; enlarged.

Winged forms began to decrease after June 15, though specimens occurred until about the middle of July. On the seventeenth of that month no winged forms could be found and no pupæ. It seems fairly certain that the third series of wingless parthenogenetic females, maturing in early June, do not produce winged forms, but only specimens similar to themselves. Examinations were not made now so frequently as earlier in the season, and specimens were preserved at intervals of from seven to ten days. A new series, the fourth of wingless breeders, was recognized on June 17. The honey tubes are distinctly shorter than in any previous series, the antennæ are comparatively shorter, six-jointed, with a sensory pit at the end of the fifth, and the tail is much longer in proportion than ever before.

No effort was made to obtain the early larvæ from this series; but toward the end of the month the presence of a small oval type was recog-

nized, and the fourth stage of quite a new series was discovered! This is regularly oval, the segments are fairly marked, the head is quite well defined, and the eyes are distinct; the honey tubes are equal to two body segments in length, quite stout, and scarcely flared at the tip; the antennæ are six-jointed, and have no sensory pittings.

August 6, the adult from this stage was first positively identified, and it differs in a most remarkable way from all previous forms. It is not over five-hundredths of an inch in length, is rather regularly oval in form, and resembles the second larval stage under the hand lens. Under the microscope the characters peculiar to the reproductive stage are at once obvious. The tarsi and tips of the tibiæ are dusky, the "tail" is prominent, the legs are long and slender, the honey tubes are drawn out into thin cylinders, equal to over three body segments in length, and the eyes are evidently pigmented. The antennæ are six-jointed and without apparent sense pits. The most striking feature is that there are only two embryos visible in any of these examples! I suspected at first that another species might have come in from the outside; but after careful study of the whole series, I conclude that this is really the fifth series of parthenogenetic or agamic, wingless, viviparous females. They continue to increase until, about the tenth of August, they are dominant, only a few of the fourth series remaining. No more than two embryos were seen in any specimen, and these were very large in proportion to the size of the mothers.

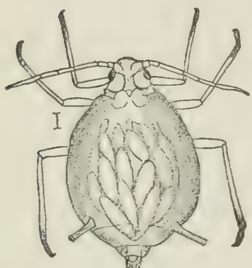

Fig. 27—Wingless, parthenogenetic, viviparous female of the fourth series; enlarged.

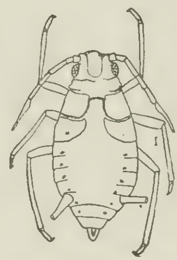

Fig. 28 — Fourth stage of larva of the fifth series; enlarged.

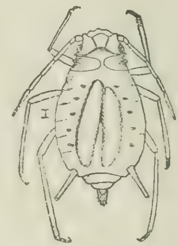

Fig. 29—Wingless, agamic, viviparous female of the fifth series; enlarged.

Fig. 30—Wingless, agamic, viviparous female of the sixth series; enlarged.

August 20, these forms had practically disappeared, and a sixth series of breeders had taken their place. These are, again,

pear-shaped, more like the earlier series, and about like the fourth series in size. The honey tubes are of moderate length, taper to near the tip, and flare a little at the point. The antennæ are six-jointed, and have an obvious sense pit at the tip of the fifth segment. August 31, all the breeding forms were of this type, and not until September 12 was the occurrence of another series of larger forms noted. These large forms increased in number until, on the twenty-fourth, none others occurred.

The specimens of this seventh series of parthenogenetic females are about seven-hundredths of an inch in length, and approach in form the stem-mothers. The honey tubes are long and slender, equal to three body segments, and the antennæ equal half tne entire length of the insect. There is a single sense pit in the fifth segment.

Fig. 31.—Wingless, agamic, viviparous female of the seventh series from beneath; enlarged.

September 27 it was seen that a new series of slender, oval examples had made its appearance, and on October 1 it was possible to distinguish the male and female larvæ. October 4 true males and females were found, and from this time on they became increasingly abundant, while the parthenogentic females as gradually disappeared, isolated specimens lingering to November 1.

A male appears like a larva in the second stage as to size; but the legs are long and slender, the tibiæ are clothed with hair, and the form of the anal segment is altogether different from any type of any previous series. The antennæ are almost as long as the entire insect, and sensory pits occur on all save the two small segments at the base. The third joint is longest, and has nine to ten pits, irregularly placed on all sides. The fourth segment is two-thirds the length of the third, and has about the same number of pits, grouped near the middle and on all sides. The fifth segment is a little shorter than the fourth, has a group of three pits around the tip and three others on the main stalk. The sixth, or whip-joint, has a group of pits at the point of enlargement. Very little difference in the arrangement of these pittings was observed in the specimens examined.

The female is one-half larger than the male, very regularly oval, a little more pointed posteriorly. The antennæ are less than half the length of the body, six-jointed, a single sensory pit at the end of the fifth, and a small group at the enlargement of the sixth joint. The legs are slender, proportionately somewhat shorter than in the male, the hind tibiæ with sensory pits irregularly placed on all sides—about eleven in number. These pits are very obscure, except on carefully prepared specimens, and there is little variation in the general arrangement.

Eggs were first observed October 10, and thence, until after November 20, the females were busily adding to them. How many eggs an individual female may lay was not noted. It was observed, however, that after laying

an egg the female would move back to a leaf or a stock and resume feeding. It is probable, the eggs being so large in proportion to the size of the insect, that only a few are developed, and that an interval of a day, or perhaps more, may intervene between deposits.

It is certain that after the beginning of September development is much less rapid than in early summer, the seventh series of breeders ranging from September 12 to November 1, though after October 1 in constantly decreasing numbers.

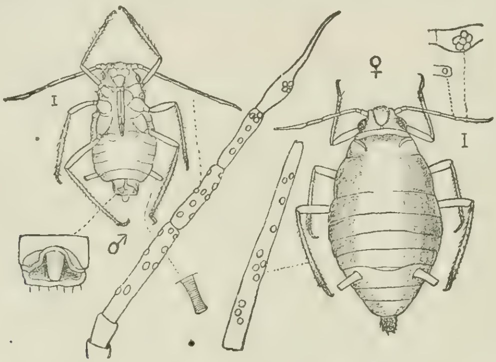


Fig. 32—Sexes of the apple plant louse: Male, to the left, with antenna, honey tube, and terminal segment yet further enlarged; female, to the right, with antennal pittings and posterior tibia more highly magnified.

This life-history covers the period from the egg deposited in the fall of 1898 to the egg deposited in the fall of 1899. The number of forms proved unexpectedly large and there may be more than I discovered. It will be necessary, before we can say that the life-history of this insect is entirely known, that each series be separately colonized and its descendents studied, free from admixture of other forms.

## SUMMARY.

The apple plant louse hatches from the egg as soon as the buds begin to develop in early spring. In about fifteen days a stem-mother becomes developed and begins to reproduce. Nine or ten days thereafter a second series matures, of which about three-fourths become winged. A third series matures about two weeks later, and of these less than one-half are winged. Thereafter no more winged forms are produced, but seven series of parthenogenetic females are in all produced, each series having peculiarities of its own. The winged forms leave the tree upon which they develop, fly to others and so spread the species in all directions in early summer. Sexed individuals are produced in October, and egg-laying begins about the tenth. It continues until late in November or, in southern counties, until the early portion of December, the eggs being black, shining, and laid around the buds, in the crotches, or in crevices generally on the trunk and branches.

## NATURAL ENEMIES.

In the course of the season I found among these aphids two species of Coccinellids or "lady-birds," three species of Syrphids or flower flies, one

species of *Chrysopa* or lace-wing fly, a very small Dipteron which was not bred, two species of parasitic wasps which have not been determined, and, most effective of all, a fungous disease. Yet this entire force of natural enemies failed to keep down to harmless numbers, the plant lice on even a small tree. I would expect that in a favorable season the disease noted would tend to become epidemic; but this is the only one of the checks that is likely to be of any practical benefit. Unfortunately we cannot always secure the co-operation of weather conditions to favor the development of the disease; hence, we must depend upon our own efforts to lessen or prevent injury.

### REMEDIAL MEASURES.

The number of plant lice on a tree can be materially lessened at any time during the season by a thorough spraying with even a comparatively weak mixture of any good contact poison. Arsenical sprays or other stomach poisons are worse than useless.

Kerosene emulsion one part, water twelve parts; or five per cent. of kerosene in a mechanical mixture with ninety-five per cent. water; or fish-oil soap one pound in six gallons of water; or a tobacco decoction equal to an extract from one pound of tobacco in two gallons of water—any of these will answer, and all of them will fail to eradicate, partly because of the difficulty of hitting all the examples when the tree is full of foliage.

Young leaves and shoots of apple are not easily wet by a watery spray, because some varieties are densely clothed with hair which sheds or repels water. Therefore, we may find, after an application, that the tips of these hairs are studded with globules of our spraying mixtures, while the aphids are digging deep in the pile, protected from injury by the very plant which they are feeding upon! Of course, oily or soapy mixtures penetrate better; but even these are repelled to some extent unless forcibly applied.

The period when our applications are likely to be most effective, and when the check to the insects is likely to be most severe, is that following immediately after they hatch from the eggs. The material best adapted for use at that time is a tobacco soap. Mr. James Good, of Philadelphia, has of late added tobacco to his potash soap No. 3, and this, at the rate of one pound in six gallons of water, applied just as the buds are opening and again a week thereafter, should be an almost complete remedy. At that time the insects are not protected by foliage, all parts of the tree can be easily reached by the spray and the insects themselves are very susceptible to the poison. A tobacco extract, like that prepared by Hammond or by the Kentucky Tobacco Product Company, will answer as well, when reduced by from ten to twenty parts of water.

A five-per-cent. mechanical mixture of kerosene and water may be equally good and is certainly less expensive. It can be thoroughly applied at this time without danger to the tree.

It is important for the fruitgrower to know that he has just fifteen days from the time when his trees first begin to show a tinge of green, to destroy the specimens that come from the winter eggs, before they can reproduce. He has at the outside ten days thereafter to prevent the development of

flying forms that will spread to parts of his orchard not previously infested.

In my own experience tobacco has given as good a result as any other material applied, and, combined with fish-oil soap, it comes as close to being a perfect remedy as it is easy to get. The trees at this early period of their growth will stand almost any reasonable application without injury, and two drenchings with either of the materials suggested, at the strength mentioned, may be safely given. It is important to remember that all these contact poisons kill only that which they actually touch; hence every application should be so made as to touch, if possible, every part of the treated tree. It is not possible to do this in all cases; but it can be done in so large a percentage of instances that the results will be satisfactory.

If trees become infested during the summer, they should be thoroughly sprayed with a somewhat stronger mixture late in September—say the twenty-fifth, and again in early October—say the fifth. This will kill the immature males and females, and will prevent oviposition.

The spraying mixtures used at this late season should be at least one-fourth stronger than those recommended for spring work, because of the greater resisting powers of the parthenogenetic females, which are at that time bearing the sexed forms. It goes without saying that thoroughness is as important at this time as at any other, and that no insects are killed other than those actually hit by the spraying mixture.

Crude petroleum is not recommended as against these insects at any time. Winter applications will fail to be effective against the eggs, which resist even undiluted kerosene in ordinary applications. Fumigation with hydrocyanic acid gas is said to kill the eggs, and this method will check the distribution of the species on nursery stock.

Trees known to be well stocked with eggs should be closely trimmed during the winter and the cuttings burnt. As the eggs are preferably laid near the tips, this method will destroy a large proportion of them. The modern method of cutting back to a single stick, trees just set out, is in line with the recommendation just made and renders the destruction of the insects easy for two years; but the cuttings must be at least removed from the orchard and preferably should be burnt, to prevent the young lice, when hatched from the eggs on the cut twigs, from crawling to the growing trees.

## METHODS OF DISTRIBUTION.

The normal or natural method for the spread of this insect is by the flight of the winged form from the trees where they hatched, to others. New orchards in somewhat isolated locations would then be comparatively free were it not for the fact that nurseries are generally infested by this insect. The eggs are therefore distributed with the young stock, and new plantations are infested from the very start, when least able to resist attack. Young trees can be very easily cleaned, however, and this is a point to which the orchardist should look if the stock has not been carefully fumigated before it was sent out.

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NOTE—All the figures illustrating this bulletin are original. The drawings were made with the camera lucida and the lack of symmetry in the pictures is due to the fact that I preferred to show the specimen just as it appeared on the slide.

# THE WOOLLY APHIS OF THE APPLE.

(*Schizoneura lanigera* Hausmann.)

By Porf. C. L. Marlatt.

### GENERAL APPEARANCE AND METHOD OF WORK.

Throughout the summer on the lower portion of the trunk and particularly on the water sprouts of the apple may often be seen small bluish-white flocculent or cottony patches. which indicate the presence of colonies of one of the worst enemies of the apple. viz.: the insect variously known in this country as the "apple-root plant-louse," "wooly apple louse," "woolly aphis," etc., and abroad very generally as the "American blight." It exists in two forms, the one just referred to, above ground on the trunk or water shoots, and another inhabiting the roots and not open to observation. Closely paralleling in these particulars the grape phylloxera, the damage from the woolly aphis is also almost altogether due to the root form, the aerial colonies causing scarcely any injury. On the roots its attacks induce enlargements or galls or swellings very similar to those produced by the phylloxera, and in the cracks of these galls or swellings the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths.

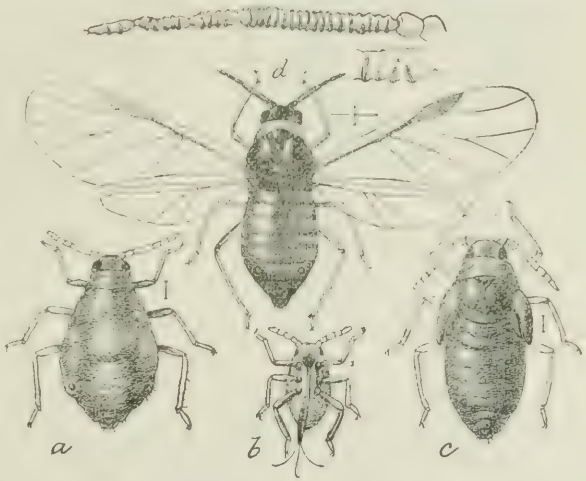


Fig. 1 — Woolly aphis (*Schizoneura lanigera*) - *a*, Agamic female; *b*, larvel louse; *c*, pupa; *d*, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed (original).

The damage is particularly serious in the case of nursery stock and young trees and less often important after the tree has once become well established and of some size. Where this insect is abundant all the roots of a young tree to the depth of a foot or so become clubbed and knotted by the growth

of hard fibrous enlargements, with the result in a year or two of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the lice, so that after this stage is reached, the cause of the injury is often obscure. On the trunks the presence of the lice sometimes results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots they collect particularly in the axils of the leaves, often eventually causing them to fall, and on the tender greener side of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the lice on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies. Injuries from the woolly aphis are almost altogether confined to the apple, even the wild crab not being so liable to attack or at least injury by it. There is, however, some difference exhibited by different varieties of apple in immunity, and particularly is the Northern Spy proof against it, and it is possible that, as in the case of the grape phylloxera, by employing root stock from seedlings of the more resistant varieties, or from wild crabs, considerable protection would result. The character of the soil also exerts some influence, that is, loose dry soils are favorable and wet compact ones are unfavorable to the aphis.

### ORIGIN AND DISTRIBUTION.

There is considerable difference of opinion as to the origin of the woolly louse of the apple. The belief has fluctuated between a Europea and an American origin for this insect, but the weight of evidence seems to indicate the latter. At any rate, it is an insect which is most readily carried from place to place with nursery stock of the apple, and it has boen so transported to practically all the important countries of the world which have been reached by colonization or European settlement. The woolly aphis was first noticed in England in 1787, on some stock imported that year from America, and was early called the American blight. Hausmann described it in 1801 as infesting apple trees in Germany, and within the next twenty-five years it was recognized as a serious enemy of this fruit tree throughout England, Belgium, North France, and Germany, but seems never to have been especially notable in the warmer latitudes of Europe.

It was very early introduced into Australia and New Zealand, and is known in India and Chile, and probably is as widespread as any of the common injurious fruit pests. Notwithstanding the possibility of its being a native American insect, it did not attract attention in this country much before 1850. Its spread since has, however, been rapid, and it now occurs practically wherever the apple is grown. It has been reported to this division from no less than thirty-five states and territories and nearly one hundred localities. It is particularly abundant and injurious in the latitude of the Ohio Valley. While seemingly, therefore, somewhat affected by

severe cold, it is able to thrive in the climate of the northern tier of states on the one hand and in that of Louisiana, New Mexico, and Southern California on the other.

### NATURAL HISTORY AND HABITS.

In common with most plant-lice, this species has a complicated life history, some of the details of which are still lacking. The common forms both on the roots and above ground are wingless lice, not exceeding one-tenth of an inch in length, and of a reddish-brown color, and abundantly covered, especially in the ærial form, with a flocculent waxy excretion. These are so-called agamic females, and reproduce themselves by giving birth, as observed by many entomologists, to living young indefinitely, perhaps for years, without the intervention of other forms. The newly born larvæ have none of the white excretion, which, however, soon appears as a minute down when they begin to feed. These lice are also peculiar in lacking the honey tubes common to most aphides, but exude the honeydew from the tip of the body. In October or November, or earlier in the south, among the wingless ones, numbers of winged individuals appear, which are also all females, and are the parents, as shown by the observations, partly unpublished, of Messrs. Howard and Pergande, of a true sexed generation of minute, wingless, larviform lice, the females of which, as in the case of the grape root louse, give birth to a single "winter egg." This egg is attached within a crevice of the bark, and, probably, following the analogy of the phylloxera, hatches in the spring into a female aphid which originates a new aerial colony.

Fig. 2—Woolly aphis (*Schizoneura lanigera*.—*a*, Root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root louse, female—*a* and *b*, natural size; *c*, much enlarged (original).

The winged females appear somewhat abundantly in autumn, and are one of the means of the dispersal of the insect. They are very minute, clear-winged, gnat-like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony excretion.

The aerial colonies are probably killed out every winter in the colder northern districts, but in the warmer latitudes the partly grown individu-

als, at least, survive protected in crevices or under bits of bark, and remain more or less active during winter and renew the colonies the following spring. This has been shown to be true in the District of Columbia, and also in the interior regions of the same latitude in spite of the much colder winters. The root form survives the winter usually in an immature condition, namely, larvæ in various stages of development, and both in latitudes where the aerial forms are killed by the severity of the winter and elsewhere it seems probable that there is a regular upward migration in spring and early summer from the roots, the aerial colonies appearing first near the crown and at a later period on the higher parts of the trees. At any time during the summer and fall there may be migrations to the roots, and throughout the year the subterranean colonies are maintained.

The spread of the insect is accomplished in part by the viviparous females, which appear in late summer, but quite as commonly perhaps by the transporting of young or partly grown individuals from tree to tree or to distant orchards by means of birds or insects to which they have attached themselves. Its wide distribution is usually dependent on the traffic in nursery stock.

### REMEDIES AND PREVENTIVES.

The foregoing account of the habits and characteristics of the woolly aphis will enable us to suggest certain measures to control it. The aerial form presents no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for plant lice, such as kerosene emulsion, a strong soap wash, resin wash, etc., the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony excretion. If the wash be applied warm, its penetration will be considerably increased.

The much more important root form, however, is more difficult to reach and exterminate. Any of the remedies which are applicable to the phylloxera will apply to the apple root plant-louse, such as the use of bisulphide of carbon or submersion. The common recommendations are of applications of strong soap or tobacco washes to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots; also similarly employed are lime and gas lime.

The most generally recommended measure hitherto is the use of hot water, and this, while being both simple and inexpensive, is thoroughly effective, as has been demonstrated by practical experience. Water at nearly the boiling point may be applied about the base of young trees without the slightest danger of injury to the trees, and should be used in sufficient quantity to thoroughly wet the soil to a depth of several inches, as the lice may penetrate nearly a foot below the surface. To facilitate the wetting of the roots and the extermination of the lice, as much of the surface soil as possible should be first removed.

Some recent very successful experiments conducted by Mr. J. M. Stedman have demonstrated the very satisfactory protective as well as remedial value of finely ground tobacco dust. The desirability of excluding the aphis alto-

gether from nursery stock is at once apparent, and this Mr. Stedman has shown to be possible by placing tobacco dust freely in the trenches in which the seedlings or grafts are planted and in the orchard excavations for young trees. Nursery stock may be continuously protected by laying each spring a line of the dust in a small furrow on either side of the row and as close as possible to the tree, covering loosely with earth. For large trees, both for protection and the destruction of existing aphides, from two to five pounds of the dust should be distributed from the crown outward to a distance of two feet, first removing the surface soil to a depth of from four to six inches. The tobacco kills the aphides by leaching through the soil, and acts as a bar for a year or so to reinfestation. The dust is a waste product of tobacco factories and costs about one cent per pound, and possesses the additional value of being worth fully its cost as a fertilizer.

The use of bisulphide of carbon for the woolly aphis is the same as for the grape root-louse. It should be applied in two or three holes about the tree to a depth of six to twelve inches and not closer than one and one-half feet to the crown. An ounce of the chemical should be introduced into each hole, which should be immediately closed. The bisulphide evaporates and penetrates throughout the soil and readily and promptly kills the aphides. It does not, however, furnish any protection from future attacks, and it is attended with danger to the tree unless the precautions named are carefully observed. That it is highly inflammable should also be constantly borne in mind. If it is to be used at all extensively, an automatic injecting device should be secured, such as the McGowan injector. The chemical costs ten cents per pound in fifty-pound cans of the manufacturer, E. R. Taylor, Cleveland, Ohio.

Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed. Slightly infested stock can easily be freed of the aphides at the time of its removal from the nursery rows. The soil should be dislodged and the roots pruned, and in batches of a dozen or so the roots and lower portion of the trunk should be immersed for a few seconds in water kept at a temperature of 130° to 150° F. A strong soap solution similarly heated or a fifteen times diluted kerosene emulsion will give somewhat greater penetration and be more effective, although the water alone at the temperature named should destroy the lice. This treatment is so simple and inexpensive that it should always be insisted upon by the purchaser if there be any indication of the presence of this insect, and stock exhibiting much damage should be refused altogether.

After planting, if the trees be kept in vigorous growing condition by careful cultivation and, if necessary, proper fertilizing damage from the lice is much less apt to occur, and the principal danger period, namely, the first two or three years after planting in the orchard, will pass in safety. The value, as a means of protection, of thorough cultivation and good care of young orchards can not be too strongly insisted upon. Vigorous growing trees have a decided power of resistance or are able to sustain with comparatively little damage the presence of the root-lice, while ill-cultivated and neglected orchards are especially liable to injury.

The woolly aphis is subject to the attacks of a number of natural enemies, including the parasitic chalcis fly (*Aphelinus mali* Haldemann), and the larva of a syrphus fly (*Pipiza radicum*, Walsh and Riley), and also the larva and adult of several species of ladybirds, the larvæ of lace-wing flies and spiders, etc. In the east a very small brown species of ladybird (*Scymnus cervicalis* Muls.), is often present in some numbers, and the common nine-spotted ladybird (*Coccinella 9-notata*), is also an active enemy of the woolly aphis. The nine-spotted ladybird has been used very successfully in California, on the authority of Mr. Ellwood Cooper, to rid trees of root-lice, which was effected by colonizing the larvæ of the ladybird at the base of the infested tree. All the parasites mentioned do much to keep the root-lice in check, and in the case of old well-established trees are in most instances a sufficient protection, but in the case of young trees and nursery stock, where the damage from the louse is much more rapid and serious, the use of the direct remedies outlined should not be neglected, and particularly should the nursery treatment be insisted upon.

# THE FRUIT-TREE BARK-BEETLE.

(*Scolytus rugulosus* Ratz.).

By J. M. Stedman, Entomologist.

## SUMMARY OF RESULTS.

From the observations and experiments conducted by this station during the past two years on fruit-tree bark-beetle, the following results are briefly summarized:

1. The fruit-tree bark-beetle is increasing rapidly, and is annually doing more and more damage and attracting the attention of fruitgrowers. It infests the plum, cherry, apricot, nectarine, peach, apple, pear, and quince.
2. The adult insects perish each fall, the winter being passed by the larvæ within the infested tree: and these transform to adults which emerge from the tree usually about the latter part of March.
3. The adult beetles make minute holes through the bark, and they and their larvæ mine a burrow just beneath the bark, thus destroying the cambium layer and killing the limb above.
4. While the fruit-tree bark-beetle is almost sure to attack first of all unhealthy, injured or dying trees or parts of trees, they will attack and injure apparently perfectly healthy trees.
5. This bark-beetle is much more difficult to control than other fruit-tree borers, but may be successfully held in check by careful attention to the following:

First—Clean culture is of first importance; every tree or part of a tree that is badly infested or is dying from any cause whatsoever should be

removed and burned at once. If from any cause this be neglected during the summer, it must be done in the winter, before March.

Second—The trees should be kept in as healthy and vigorous a condition as possible by cultivation and fertilization.

Third—The trunks and large limbs, and as many of the smaller limbs and twigs as possible, should be kept covered with a repellent wash which should be applied just before the beetles emerge in early spring, by means of a force pump, and as often as necessary thereafter until the leaves appear, after which it should be applied by means of a white-wash brush to the trunks and larger limbs.

6. We have found the best wash to be the following: Dissolve as much common washing soda as possible in six gallons of soft water, then dissolve one gallon of ordinary soft soap in the above and add one pint of crude carbolic acid and mix thoroughly: two pounds of lime is then slaked in two gallons of water and filtered so as to remove all dirt and small lumps; this is now added to the above and mixed; while to all is added one-half pound of paris green or one-fourth pound of white arsenic, and thoroughly mixed.

7. The above wash, made thicker by the addition of lime, we have found to be as good as any, and much better than most, washes to apply to the trunks and large limbs of apple and peach trees in order to prevent the attack of the common peach-tree and apple-tree borers.

## GENERAL REMARKS.

Two years ago our attention was called to the importance of the fruit-tree bark-beetle by the numerous letters this office received from fruitgrowers in various parts of this state. Many of these letters were accompanied by specimens of the beetles and their work, while those that were not were usually explicit enough to enable me to place the cause of the trouble. At that time we believed, as most entomologists still do, that these beetles attack only diseased, injured, devitalized, or dying trees, and advised our correspondents accordingly. The great number of inquiries, however, led us to make investigations and experiments in order to determine whether or not this insect was really doing the damage it was reported to be causing, and, if possible, to find some method to obtain relief.

## DISTRIBUTION.

This pest is another example of an imported insect, it having been introduced into the United States from Europe, where it has been known for some time; but appears to be held in check by parasitic insects, and is not there regarded as especially destructive. It was first noticed in this country near Elmira, New York, in 1877, where it was doing injury to the peach. It has spread until it is now found in damaging quantities in the eastern half of the United States from Massachusetts in the east to Kansas in the west, and from Michigan in the north to Alabama in the south.

### ITS FOOD HABITS.

In this country the fruit-tree bark-beetle attacks various varieties of the plum, cherry, apricot, nectarine, peach, apple, pear, and quince. In Europe it not only infests the above fruit trees, but also works on the elm, mountain ash and hawthorn. Although it has apparently never been recorded as attacking these trees in the United States, nevertheless it may possibly do so later. The stone fruits seem to be more especially subject to the attacks of this beetle, the plum, perhaps, most of all; but since our orchards are principally peach and apple, it is with these trees that the greatest amount of damage is done, if we consider the state at large. Fully three-fourths of the complaints from this beetle have been from its work on these two fruits.

From what we have observed during the past two years, it is evident that the beetles prefer and will attack first of all those trees or parts of trees that are injured, weakened, or dying from any cause whatever; still we have seen many trees infested with this insect that were apparently as healthy and sound as any tree, and for that reason it appears this insect is capable of doing more damage than was at first supposed.

It is very largely a matter of opinion when one pronounces a tree perfectly healthy that has become infested with this pest, but, no doubt, one should regard a tree as healthy when there is absolutely no reason to suspect anything different except that it has now become attacked by this insect. Those who still entertain the oponion that this beetle will attack only devitalized trees, would surely have trouble in detecting all such cases of devitalization in our orchards, were no fruit-tree bark-beetle present to lead the way. Looking at the subject from another point of view, it may be a question whether any of our apple trees, for instance, are not devitalized that are found in the southern half of this state, where it is practically impossible to find them free from the wooly aphis. Nevertheless, it seems plausible to regard the greater bulk of these trees as healthy.

No doubt one of the greatest agencies at work to assist in the multiplication of this beetle in Missouri is the wooly aphis, which has so devitalized and killed such a large number of the apple trees in southern orchards that it has made the conditions most favorable to the development of this bark-beetle in those trees. The greater number of peach trees that are attacked by this bark-beetle owe such an attack to the fact that they are suffering in our orchards from the work of the peach-tree borer, which is weakening and killing many, and from the winds and overbearing, which are breaking large limbs and forming the best of breeding places for this pest. It is sure to attack such trees first. Trees that have just been transplanted, as in setting out a young orchard, are also frequently attacked by these beetles, but this may be largely due to the checked vigor resulting from such a change. A perfectly healthy and vigorous tree will frequently repel the attack of the fruit-tree bark-beetle by the copious flow and exudation of sap. This is especially the case with the stone fruits, where the beetles appear to be driven away by this means, and are unable to burrow to any considerable distance below the bark and are unable to deposit their eggs.

When the bettles attack a comparatively small limb, perhaps the first

indication will be a withering of the leaves, while a closer examination will show the bark to be more or less shriveled, as can be seen by referring to the photograph in Fig. 1; and later, when the adult beetles emerge, the small "shot holes" will be conspicuous. If the bettles attack a large limb or trunk, the work may go on for some time before it is observed; but usually one will detect the flow of sap, especially if it be a stone-fruit tree, where the exudation of drops of gum will be sure to attract attention, and may even be very conspicuous and run down the tree to the ground.

### HABITS AND LIFE-HISTORY.

The fruit-tree bark-beetle is a small cylindrical beetle about one-tenth of an inch in length and one-third as wide as it is long: nearly or quite black in color, with the very tips of the elytra or wing covers and portions of the legs reddish brown. Under a hand lense one can make out the peculiar markings on the back—thorax and elytra—and the short hairs on the head and wing covers. A fair idea of the general appearance of these beetles as seen under a lense can be had by observing the drawing of one magnified in Fig. 2, a, while a side view in outline is shown in Fig. 2, b. This beetle belongs to the family *Scolytidæ*, which includes a number of similar, small bark and wood-boring beetles that the ordinary observer will not be able to separate from the one under discussion except by a close observation of its habits and work.

*a* *b* *c* *d*

Fig. 2—The Fruit-Tree Bark-Beetle, *Scolytus rugulosus* Ratz. *a*, adult beetle; *b*, same in profile; *c*, pupa; *d*, larva. All magnified about ten times. (From Chittenden, circular 29, SS. Div. Entomology, U. S. Dept. of Agriculture.)

The adult beetles begin to emerge about the last of March in most seasons, and may soon begin to feed by eating small round holes through the bark of the tree. These holes are usually made near the base of the larger limbs, and about forks and old scars or lateral spurs, but are also common on the smaller limbs and even on the small twigs: while in badly infested trees they may occur on the trunk as far down as to be within a short distance of the ground. The holes through the bark are small, not much larger than the cross-section of a large pin, or about one-eighteenth of an inch in diameter: and for this reason are frequently spoken of as "pin holes," and the beetles as the "pin-hole beetles." Where these holes are very numerous they give the limb the appearance of having been shot or peppered full of holes with fine bird shot: and this again has led to another

common name for the beetles — "shot-hole borers." Fig. 1, shows the appearance of a twig, natural size, infested with these beetles; and the holes and shriveling of the bark can be seen fairly well.

The first holes are made by the adult beetles that eat directly through the bark until they reach the wood, then they tunnel between the bark and the wood, making a hole from an inch to an inch and a half in length, and slightly larger than the insect. This burrow is almost invariably in the direction of the long axis of the limb or very slightly oblique, and is made in the cambium layer, including a little of the wood on the one side and a little of the bark on the other. As the females make this burrow, which is known as the brood chamber, they deposit their eggs to the right and left along its course. The minute grubs hatching from these eggs eat little tunnels or side galleries at right angles to the brood chamber, likewise keeping in the cambium layer and including a little of the wood and a little of the bark. As they increase in size they make the burrows larger in diameter accordingly, and soon begin to turn the tunnels in the direction of the long axis of the limb and parallel to the brood chamber. These side galleries are lengthened as the larvæ feed until they are about as long as the brood chamber, or possibly longer, by which time the grubs have become full grown larvæ. They are small, white, footless grubs with brown heads, one of which is represented magnified in Fig. 2, d. They then eat a little deeper into the wood and thus make a small chamber, known as the pupal chamber, stopping up the entrance with pieces of wood, and there change to pupæ. A pupa is represented magnified in Fig. 2, c.

When the adult beetles emerge they simply eat through the bark to the exterior and escape. Thus it is that the limb becomes so full of the small holes through the bark: and as each female deposits about eighty eggs, as can be readily determined by counting the side galleries of the brood chambers, one can readily imagine the result when the adults emerge. From a short section of a small limb, one-half of which is photographed in Fig. 1, there emerged in the laboratory one hundred and sixty-seven adult beetles of one brood.

As the great bulk of the young beetles soon attack the same tree from which they emerged, and eat holes through the bark, and burrow in order to deposit their eggs for another brood, it can readily be understood that it does not require much time before these insects have completely undermined the bark, and, by destroying the cambium layer, have killed the limb above the infested place.

By removing the bark from an infested limb one can readily see the shape of the burrows engraved upon the wood and upon the bark, and, where the limb is badly infested, one will find the galleries so close together and so interwoven that it is difficult to trace the work of a single family. Fig. 3 shows an enlarged picture of such a limb with the bark removed.

In Missouri this beetle has sometimes three and sometimes four broods during a season, each brood requiring on an average five weeks for its completion; but as the beetles do not all emerge at once, and vary considerably in a single tree, the result is the different broods tend to overlap somewhat, and we have found it very difficult to exactly trace the broods for

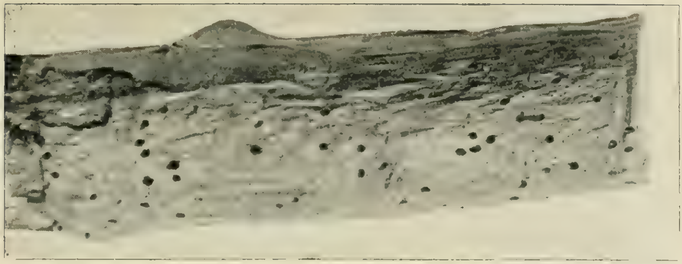

FIG. 1.—Photograph of a portion of an apple tree twig infested with fruit-tree bark beetle, showing the "pin-holes" or shot-holes" and the shriveled bark, natural size.

FIG. 3.—Enlarged view of the galleries of the fruit-tree bark beetle, as seen on an infested limb from which the bark has been removed. (After Ratzenberg).

FIG. 4.—Chiropachys Colon. Much enlarged. (After Howard).

a certainty. However, this is not of as much importance as the fact that the adult beetles all perish in the fall, the winter being passed by the larval stage within the infested trees; and this, no doubt, is the key to the situation of successfully combating this pest.

REMEDIES.

The fruit-tree bark-beetle is attacked in its larval form while within the infested tree by a number of small hymenopterous parasites, perhaps the most common of which is *Chiropachys colon*, represented much enlarged in Fig. 4. These insects are capable of doing considerable good in holding the beetles in check, but our experience has been that they are not yet numerous enough in Missouri to materially lessen the damage from the borers. They may some day, however, multiply so as to hold the bark beetle in check.

While all fruit-tree borers are difficult insects to combat, the fruit-tree bark-beetle is by far the most troublesome, owing to the fact that it is so small and occurs in such large numbers, while it deposits its eggs practically all summer and infests all parts of the tree above ground except the leaves and fruit.

From the habits of the insect one can readily see that the most essential thing to be done is to keep the trees in a perfectly healthy and vigorous condition, and free from any injury or weakness, or from injured, weakened, or dying parts. This can be done by careful cultivation and fertilization, and by clean culture. Although this pest will infest perfectly healthy trees, it is so much more liable to attack weakened or dying trees that it becomes important that clean culture be practiced, at least insofar as to remove from the orchard and to burn all dead and dying trees or portions of trees. The sooner this can be done the better. If for any season it has not been done during the summer it must be done during the winter, and all such trees and limbs burned before March, thereby destroying the insects before they emerge. When a tree or portion of a tree is seen to be dying it is useless to try and save it, and it should be removed and burned at once. Of course a fruitgrower must use his own judgment in discriminating between those that will recover and those that will not; but it is safe to say that if it be attacked to any considerable extent by this pest it is better to remove and burn it.

Mechanical barriers, such as wrappers, are of little value in preventing the attack of this insect, except to keep them away from the trunk, and, perhaps, the large limbs: and on this account it is better to rely upon some wash that can be aplied over a larger part of the tree.

We have used a wash made by dissolving one pound of potash whale-oil soap in two gallons of water, and applied about the middle of March by means of a spray-pump, and again about the first of April, and have observed good results in repelling the attack of this beetle as long as the rains allowed the soap to remain on the trees to any considerable extent; but this spray is too strong to be used when the trees begin to leave out, and on that account it is better to use other washes.

While we have used, with more or less success, a number of different

washes, we have found the following one to give the best results: Dissolve as much common washing soda as possible in six gallons of soft water, then dissolve one gallon of ordinary soft soap in the above and add one pint of crude carbolic acid, and mix thoroughly; two pounds of lime is then slaked in two gallons of water and filtered so as to remove all dirt and small lumps; this is now added to the above and mixed, while to all is added one-half pound of paris green, or one-fourth pound of white arsenic, and all thoroughly mixed together. While the lime may be omitted we have found it of value in helping to hold the other substances on the tree, and in being of itself disagreeable to the beetles, but use it principally to enable one to tell exactly where and to what extent, or, in other words, how thoroughly, the spraying has been done. The paris green or white arsenic may be omitted, and the wash will still act as a repellant; but the addition of the poison has advantages in that it will kill the beetles that try to effect an entrance. It is, perhaps, needless to say that all washes should be applied as thoroughly as possible in order to cover all portions of the tree that it is intended to protect. We have applied the above wash on the trees by means of a spray-pump with perfect success and have reached and covered the entire tree when not leaved out. When the trees are leaved out, it is not practicable to apply the wash by means of a spray-pump, since the leaves catch the bulk of the spray and prevent the wash from thoroughly covering the small limbs and twigs where the benefit is to be derived.

The above wash should be appled to the trees by means of a spray-pump just as soon as the adult beetles begin to emerge, which is about the last of March, as a rule; and other applications should be similarly made as often as needed until the trees leave out, after which any further application should be made by means of a white-wash brush to the trunks and large limbs. The above amount of paris green or white arsenic is too strong to apply to the foliage of fruit trees, and for that reason should be omitted entirely if spraying the peach or plum after they are in leaf, and should be reduced if spraying other fruit trees while in leaf. When the trees are leaved out, however, the wash should be applied to the trunks and larger limbs only, and by means of a brush, and in that case the presence of the large amount of poison will do no harm.

The above wash, while very effectual in preventing the beetles from attacking a tree, will not kill the insects when they are once within the tree. Should one discover that the beetles have just attacked a tree where one can get at it, they may be killed by touching their entrance with a sponge or rag on the end of a stick and saturated with a mixture of creosote oil one part, turpentine two parts. After the insects have been killed, it is necessary to apply the wash in order to prevent others from entering.

# THE LARGER APPLE-TREE BORERS.

By Prof. F. H. Chittenden.

Among the most troublesome of the insect pests with which the fruit-growers of the United States have to deal are two species of boring beetles known, from the appearance of their larvæ, as the round-headed and flat-headed apple-tree borers. In addition, there is another species called the spotted apple-tree borer, after the adult form, and to distinguish it from the round-headed borer, which it closely resembles. The two species first mentioned are common and injurious throughout a wide extent of country—the former to seed fruit trees, the latter also to stone fruit, as well as to a great variety of forest and ornamental trees: the third is a comparatively rare insect and rather exceptionally injurious so far as known.

## THE ROUND-HEADED APPLE-TREE BORER.

(*Saperda candida* Fab.)

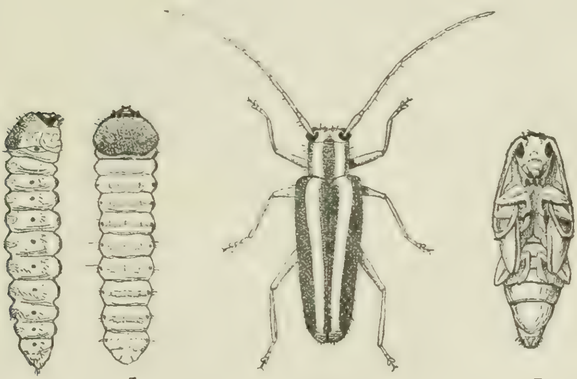


Fig. 1—*Saperda candida*: *a*, larva, from side; *b*, from above; *c*, female beetle; *d*, pupa—all enlarged one-third (original).

### INTRODUCTORY REMARKS AND DESCRIPTION.

The round-headed apple-tree borer is next after the codling moth, the worst enemy to apple culture in America.

The first intimation that the grower may have of the presence of this borer in his trees, unless he be forewarned, is in their retarded growth and the sawdust-like castings, consisting of excrementitious matter and gnawings of woody fiber, which the larvæ extrude from openings into their burrows. This manifestation is usually accompanied by more or less evident discoloration of the bark, and, in early spring, particularly, slight exudation of sap.

The parent of this borer i a beautiful beetle, measuring from three-fourths to nearly an inch in length, the mail being perceptibly narrower than the female. The antennæ are long, stout, and many-jointed, being somewhat shorter than the body of the insect itself. These organs and the legs are gray, the under surface of the body and the head are silvery white, and the upper surface is light yellowish brown with two longitudinal white stripes extending through the thorax and elytra or wing-covers to the tip, as shown in the accompanying illustration (Fig. 1, *c*).

The larva when mature measures from three-fourths to a little over an inch in length (twenty-two to twenty-six milimetres). It is fleshy and somewhat grub-like in appearance, cylindrical in form, and light yellow in color. The head is darker, particularly about the mandibles, which are nearly black. The first thoracic segment is large and broad and bears on its summit numerous small tubercles, placed closely together. The remaining joints of the body are narrower, the constrictions between them being deep and conspicuous. The first seven abdominal segments bear on the upper surface of each a peculiar elevated process, as shown at Fig. 1, *b*. It is destitute of organs of locomotion.

The pupa, illustrated at *d*, is nearly as long as the adult insect, which it resembles in a superficial manner, the head being bent down toward the breast, and the legs and long antennæ folded upon the ventral surface. Its color is similar to that of the larva.

*Saperda candida* was given its specific name by Fabricius in the year 1787, and was again described as new by Thomas Say, in 1824, under the name of S. *bivittata*, who remarked at the time upon its being injurious to the apple tree by boring into the wood.

DISTRIBUTION.

This species is native to this country and present in injurious numbers in practically every state of the apple-growing region east of the Rocky Mountains. It inhabits, like so many other injurious insects, the upper austral and transition life zones, comprising the better agricultural portion of all. except the extreme southern states. It has been reported to occur in one locality, Agricultural College, Mississippi, which lies in what is considered the lower austral zone. As with many other injurious species again, it is in the older states, particularly New England and New York, where orchards have been long established, that injuries are most pronounced. Until recently this species was not known as especially injurious about the District of Columbia, but at the present time it has become very abundant and destructive, whole orchards of both young and mature trees having succumbed to its ravages.

Its known distribution as shown by published and unpublished records, in the possession of this office, includes Canada, all of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, District of Columbia, Ohio, Illinois, Michigan, Iowa, Missouri, Kansas and restricted localities in Texas, Alabama and Mississippi.

### FOOD PLANTS AND NATURE OF INFESTATION.

This borer is practically limited in its food supply to the apple and kindred woody plants. It is most injurious to quince and apple, and somewhat less troublesome to pear. It also infests crab apple, and thorns of different species, choke-berry and June-berry, in short practically all except one or two kinds of trees and shrubs belonging to the genera now included in the restricted family of Pomaceæ. The wild plants are its natural food and certain varieties at least, although often inhabited by this insect, are for some reason not so susceptible to injury by it as our cultivated trees.

This species inhabits more particularly the base of the trunk of trees, often being found below the surface of the earth, especially in young nursery stock. It is to such trees that it is most injurious as it soon works around the tree, separating the wood from the bark, interfering with the flow of sap and producing the effect of girdling, a result which is very apt to be produced even when no more than two or three larvæ occur upon the same tree. Very frequently four or five larvæ dwell together in a single small tree and in a short time injure it entirely beyond recovery. In older trees larvæ occur somewhat higher up the trunk, in exceptional cases at a distance of several feet from the base or even, still more rarely, in the lower limbs; but as a rule they are seldom found except within a foot or two of the base. Trees of all sizes are frequently killed or so weakened that they are unable to mature a full crop of fruit.

The experience of many years shows that injury follows where grasses, weeds, or other rank vegetable growth are permitted to accumulate about the trunks of the trees, since the beetle, like all nocturnal insects, naturally seeks concealment, and the conditions thus afforded are most favorable for its attack on cultivated plants.

### LIFE-HISTORY.

The beetles make their first appearance of the season late in May and in June, according to locality, coming forth from the trunks of the trees in which they have bred during the night, at which time the species, being nocturnal, may be seen in flight. During the day the beetles hide away in some secluded place under the leaves or in similar situations on the trees which they inhabit.

Soon after their first appearance the sexes mate and eggs are deposited. The female first makes an incision in the bark, whether by means of her mandibles or ovipositor is not plain, causing it to split slightly, then turning, head upward, places an egg under the bark nearly a quarter of an inch from the incision, accompanying the deposition by the extrusion of "a gummy fluid which covers and secures it to its place and usually fills up the aperture. In young trees with tender bark the egg is usually thoroughly hidden, while in older trees it is sometimes so shallowly imbedded as to be readily seen."

"The egg is pale rust-brown in color, one-eighth of an inch long, one-third as wide at the middle, flattened so as to have a depth of about one-

third the width." Its shell is fairly tough and resistant, not sculptured and sufficiently plastic, when laid, to receive impressions from the woody fibers between which it is forced. Oviposition has been observed from June to September in a single locality (Lawrence, Kansas), but June is the month in which most of the eggs are laid.* Fitch and others observed the beetles in the trees, near Albany, New York, as early as April.

The period of the egg from the time it is laid until it hatches, rests upon the statement of Mr. E. W. Junkins that a young borer larva was observed July 7 from eggs† that were deposited June 15, which would give a period of twenty-two days.

The larvæ soon after hatching tunnel under the bark and feed upon the sap-wood, gradually working their way upward and afterward downward, usually, particularly young trees, remaining within a short distance of, or below the surface of, the ground. By the beginning of the second year the larvæ, according to recent observations conducted by the writer, attain an average growth of about five-eighths of an inch. The larval growth will naturally vary according to temperature, moisture, and quantity of food available for consumption, and other conditions. With the approach of cold weather the larvæ cease feeding, but with the beginning of warm spring weather—in the District of Columbia as early as the latter days of March—they again commence, forcing their excrement and castings consisting of gnawed particles of wood out through holes which they make in their burrows. By the end of the second year the larvæ have increased considerably in size and have now penetrated deeper into the solid heart-wood, their burrows being closely packed behind them with castings. The third year the larvæ gnaw outwards to the bark, form a pupal cell with the assistance of their castings and, wtih their heads pointing toward the bark, transform to pupæ. With the approach of May and June they cut their way out by means of their powerful mandibles and issue through a round hole as mature beetles. The period of the pupil stage does not appear to have come under observation hitherto. A larva was observed by the writer at the Department of Agriculture that pupated May 11, and appeared as adult May 30, which gives nineteen days for this period; weather seasonable.

### NATURAL ENEMIES.

Concealed as this insect is during its three years of existence in its preparatory stages it is nevertheless a prey to natural enemies which seek and devour it in its haunts under the bark. Of this number are woodpeckers and hymenopterous parasites. Of the latter only a single species is known to the writer, *Cenocœlius populator* Say.‡

### METHODS OF CONTROL.

After borers have once entered a tree there is no better remedy known than to cut them out with a knife or other sharp instrument. In the treat-

*Above quotations from account by Riley in New York Weekly Tribune, February 20, 1878; Kansas Horticultural Report for 1879, pages 196–201.

†New England Homestead, January 3, 1885.

‡Mentioned in Insect Life, Vol. III, p. 59, as *Promachus saperdæ* Riley MS.

ment of this insect an ounce of prevention is worth several pounds of cure. Cutting the borers out, unless practiced with the greatest care, is apt to result in injury, and it is far better to prevent the parent insects from depositing their eggs upon the tree. This is not difficult to accomplish, as oviposition is practically confined to two months in a single locality, usually during June and July. The best preventives are impenetrable substances placed about the trunk, and various washes of a repellant nature.

*Cutting out by hand*—Little has been gained in the line of direct remedies for this borer until very recent years. The early writers had nothing better to advise than cutting out the larva, either with a knife or gouge, or killing them by the insertion of a wire into their burrows. These remedies were in use early in the present century and are still the ones most often practiced. It is no uncommon thing to find four or more larvæ in a single small trunk and the cutting out of all of them, if not practiced with the greatest caution, is apt to result in the girding of the tree, if, indeed, this has not already been accomplished by the combined attack of the borers themselves. It would seem superfluous to add that it is best to cut the borers out as soon as detected. Their presence may be known by a little experience, some persons, the writer is informed, being so expert in detecting their exact location as to be able to kill them with a knife thrust or by the puncture of an awl or other sharp instrument. The fruitgrower should institute a practice of inspection that the borers may be removed as often as found.

To assist the tree to recuperate after it has been girdled, a bridge or two should be made by splitting a piece of apple twig (say, an inch or two in thickness), cutting it diagonally on the inside, and applying to the surface at the base of the tree. It should then be tied on and grafting wax applied to each end, after which a fertilizer, perfectly fresh cow manure, should be applied and the whole banked over with earth. It is also well to keep the tree watered for a few weeks after treatment whenever this is practicable without too great inconvenience.

*Mechanical preventives*—This is one of the borers that can readily be controlled by different sorts of mechanical barriers placed about the base of the tree. For this a few thicknesses of newspaper wrapped rather loosely about the trunk and extending about two feet from the base are all that is necessary. This covering should be tied, by preference with cord, which will readily yield or break with the natural expansion of the tree in its growth, and also be tightly fastened at the top or bottom and hilled up with earth so that the beetles can not obtain access to the tree from below. From the top of this covering upward it is best to use some deterrent alkaline or carbolated wash. Instead of newspapers, wire gauze or mosquito netting may be used, and should be put in place, so as to loosely encircle the tree, that the beetles may be unable to successfully deposit their eggs between its meshes and that the growth of the tree may not be hindered. Both have been successfully employed for a long period of years, and there is abundant testimony to their value. If the netting or paper be put in place early in May, it will not only prevent the beetles from ovipositing during the next two months but will also keep the insects which might be present in the trunk from issuing, and they will die in their burrows without being able to lay fertilized

eggs. The paper wrapping must be removed each season, but the wire netting will last for several years. It is safe to remove either, ordinarily, after the first of September.

Hydraulic cement mixed with skim milk, recently advised by Dr. J. B. Smith as a remedy for the peach-tree borer, should prove equally effective against this apple-tree borer. It could be applied with less trouble than paper bands.

*Protective washes*—Any one of several washes in general use against boring insects may be used as deterrents. A good alkaline wash is prepared of soft soap reduced to the consistency of thick paint by the addition of caustic potash or washing soda in solution. A good fish-oil, or whale-oil, soap or common soft soap are often used, and in some cases any one of these is sufficient to deter the insects from depositing their eggs. The alkaline wash may be carbolated, if desired, by the addition of crude carbolic acid, at the rate of one pint to every ten gallons of the wash. Such a wash, it should be borne in mind, not only affords protection against this and other borers, but against scale and fungous diseases at these points, and is, moreover, of positive benefit to the tree. Caustic potash fish-oil soaps are among the best for insecticides.

Whatever wash is used should be applied thoroughly, and in localities where apple-tree borers are unusually troublesome the larger branches should also be covered as far as possible. The wash may be best applied with a whitewash brush, and should be renewed at intervals of two to four weeks, as found necessary, the first application being made before the appearance of the insects in May or June and again during July.

It is well to scrape old trees to remove the dead bark scales, care being taken not to cause any abrasion which would injure them. Scraping is best done some time before the application of the wash, that the wounds that might be made shall have opportunity to heal before the appearance of the beetles.

*Destroying the adult insects*—The mature beetles are shy, and so seldom seen on this account that it is doubtful if any method of destroying them is feasible. They are attracted to lights at night to some extent, and some meet their end in this way. Very early in the morning, immediately after daybreak, the beetles may be found upon the trees, if sought for in their season, and may then be beaten off into an inverted umbrella by striking the branches with a stout stick.

*Kerosene as a remedy*—A great variety of substances have been recommended to kill the borers in the trees, but up to the present time only a few have given satisfaction. For the benefit of those who have not had experience with this borer, it may be necessary to state that it is of no avail whatever to inject kerosene, or any other insecticide, into the round holes made by the beetles in their escape from the trees. A correspondent of this division, Mr. T. B. Ashton, who has had many years' experience with this borer, states that there is no better way of effectually putting a stop to the depredations of this and similar borers than in the use of kerosene applied freely wherever the castings of the larvæ are to be seen protruding through the bark. The kerosene is absorbed by the castings, and, carried by capillary

attraction, permeates the entire burrow where it comes in contact with the larva, which soon succumbs. The amount of kerosene which it is necessary to use is so small that it does not endanger the health of the tree.

*Clean cultural methods*—Finally, clean culture, the best preventive for insect injury of whatever kind, should not be neglected. The nursery should not be started in new localities, where crabs, thorns, June-berry, and other wild food plants of this species grow in great profusion, nor in the vicinity of neglected orchards, nor should rank growths of weeds, grasses, bushes, and briars be permitted to accumulate about the trunks of the trees. When a tree is seen to be injured beyond recovery it should be taken out and destroyed by burning before the following spring, that the larvæ which it contains may not have an opportunity to develop and reinfest healthy growth.

## THE SPOTTED APPLE-TREE BORER.

(*Saperda cretata* Newm.).

A very similar insect to the preceding, both in appearance and in habits, is the spotted apple-tree borer (*Saperda cretata* Newm.). The adult beetle is of nearly the same size and form as the round-headed borer, differing superficially by having two white spots on each elytron instead of the longitudinal white lines which distinguish the latter. (See Fig. 2.) The larva and pupa are so similar that no description need be made of them. Although the species has a fairly wide distribution, corresponding somewhat closely to that of the common species, specific injury by it has only been noted in two states, in Michigan by Prof. A. J. Cook, and in Iowa by Prof. H. Osborn. In the former state this borer is reported as quite as common and destructive as *Saperda candida*. Its occurrence is also recorded in Canada, New York, Pennsylvania, New Jersey, and Ohio, and there are specimens in the national museum also from Northern Illinois and Texas. It has only been observed injuring apple and wild crab, but its occurrence has also been noted on June-berry and thorn. According to Osborn the "eggs are evidently laid in pairs, half an inch or more apart, along the branch, the larvæ of each pair upon hatching working in opposite directions around the branch, at first just beneath the bark, afterward (probably after the first year) entering the hard wood."

Fig. 2—*Saperda cretata*: female beetle—enlarged one-third (original).

The remedies for this species are the same as for the preceding, with the extra precaution that the larger branches also be protected by the wash applied.

NOTE.—A third species of Saperda, *fayi* Bland, has similar habits, and is likely to attack apple and similarly cultivated pomaceous trees, but is thus far known only on thorns. A very full account of this species was published by the late Doctor Hamilton (Can. Ent. Vol. XX, pp. 6–8).

## THE FLAT-HEADED APPLE-TREE BORER.

(*Chrysobothris femorata* Fab.).

### GENERAL APPEARANCE AND NATURE OF INJURY.

A much less dangerous, though more abundant, insect than any of the preceding, is the flat-headed apple-tree borer. It belongs to a different family of Coleoptera, the short-horned wood-borers or metalic beetles of the family Buprestidæ, and differs remarkably from the preceding in all its stages as well as in its habits and life-history.

The adult insect (represented at *b*, Fig. 3) measures from a little less to a little more than a half inch in length. It is flattened above, resembling somewhat a snapping beetle, but it is not provided with jumping organs like the Elateridæ. The antennæ are short and serrate, the eyes large and conspicuous, and the forelegs are armed in front with a conspicuous tooth. The upper surface of the body is dark metallic brown, and fresh specimens are coated here and there with a powdery gray substance, which is easily rubbed off. The wing-covers are ornamented as shown in the illustration, and underneath, as may be seen when the insect is in flight, the body is a bright metallic greenish blue. The under surface is coppery bronze. The males are smaller and may further be distinguished from the females by their green heads as well as by other characters (see Fig. 3, *c*.)

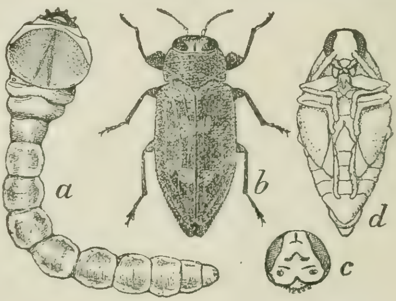

Fig. 3—*Chrysobothris femorata*: *a*, larva; *b*, beetle; *c*, head of male; *d*, pupa—twice natural size (original.)

Unlike the round-headed borer the present species is diurnal in habit, being most active in the heat of the day and commonly found on prostrate trees and logs, or on injured trunks basking in the sunlight. The beetles are active creatures, running rapidly and flying readily.

This species attacks by preference diseased or dying trees, inhabits all parts of a tree from the base of the trunk to the limbs, and is not restricted in its ravages to fruit trees, but attacks also a variety of deciduous trees.

In all these respects it differs from the round-headed borer, but agrees with the latter in that it is injurious chiefly to young trees, its injuries being practically confined to newly transplanted nursery stock and to trees which have been weakened through any cause, such as careless pruning, or insufficient nourishment due to poor soil or drouth. There is a difference of opinion as to the nature of damage, some writers taking the stand that healthy trees are not injured at all. It is a well-known fact that many forms of boring insects prefer injured plants, but when this is wanting do not hesitate to attack perfectly sound growth, and records show conclusively that the present species is included in this category. The general opinion is that trees suffering from "sun scald" are most subject to attack, and the

opinion has been expressed that injury known under this name is in reality due to the work of this species of borer. The beetle is essentially a sun-loving species and deposits its eggs practically exclusively on the southern or southwestern sides of standing trees or on recently felled logs that are exposed to direct sunlight. Observation shows that it is doubtful if the young larvæ would be able to withstand the strong flowing sap of vigorous trees.

Infestation may be detected by the discoloration of the bark.

A list of its recorded food plants includes, among orchard trees, apple, pear, peach; and of shade and forest trees, mountain ash, oak, maple, box-elder, hickory, chestnut, sycamore, horse-chestnut, linden and willow. To this list should be added plum and cultivated redbud (*Cercis japonica*), from which the species has been reared by the writer, and currant.*

Cherry, beech, and white birch are probably food plants, although the beetle has not been reared from them, and elm, tulip, and cottonwood have been mentioned as such, but on what authority is not clear. Oak is without doubt the natural host tree.

The larva differs greatly from that of the round-headed borer. Its name of flat-headed borer is derived from the peculiar flat expansion of the second thoracic segment, the one just behind the head. In color it is a light yellow, and in length it measures nearly twice that of the mature insect. It habitually rests in a curved position, more bent usually than shown in the illustration (Fig. 3, *a*). The pupa (*b*) shows the form of the future beetle and is of the same yellow color as the larva.

This species inhabits practically the entire United States and the southern portion of Canada, being like the preceding, a native of North America and injurious year after year.

## NATURAL HISTORY AND HABITS.

The beetles make their appearance about the same time as the round-headed borer, in regions infested by both species, in the principal apple-growing regions of the northern states after the middle of May, and continue through the month of July, and, it is said, even into September, the female depositing her eggs upon the trunks or branches of trees destined to be the future food of the larva, in cracks and grooves or under bark scales. Several eggs are most frequently found together. The eggs are yellow in color, irregularly ribbed, and about one-fiftieth of an inch in length.† The larva differs from the round-headed borer in that it requires only a single year for its development, pupation occurring in the spring shortly after the appearance of the beetles. It differs also in its manner of work, living for the most part just beneath the bark, where it excavates broad, flat, and very irregular channels, but sometimes entering more deeply into the sap-wood. Like many other borers it often girdles a small tree, a single individual being capable of killing a small tree in this manner. As it approaches maturity it generally eats deeper into the solid heart-wood, but in

*F. H. Hillman, Nevada Experiment Station, Bull. 36, p. 18.
†C. V. Riley, Proc. Ent. Soc. Wash., Vol. III, p. 92.

springtime, just before transformation, it works back again into the bark, and there constructs its pupal chamber. In the pupa state it is said to remain for about three weeks,* when the beetle cuts its way out, leaving an elliptical exit hole in the bark, which distinguishes its work from that of the round-headed borers, which make round holes in their exit, these holes corresponding to a cross-section of the beetle which makes them. In the north the winter months are passed as larvæ, but further south, in the District of Columbia, according to recent observations, pupation may take place as early as November the first year.*

### NATURAL ENEMIES.

Among natural enemies, woodpeckers are effective destroyers of this species, as are also ants, which devour larvæ and pupæ under the bark. A number of parasitic insects also prey upon it and assist greatly in restricting its too great abundance.†

### REMEDIES.

The remedies advised for the round-headed borer are also of value and are generally employed against the present species. It is necessary, however, that deterrent coverings and washes should be applied farther up the trunk and to as many branches as can be conveniently reached. As this, however, necessitates additional labor and extra expense, other preventive measures are recommended.

*Trap wood for beetles*—For this purpose any sort of tree known to be freely attacked by this borer, e. g., oak, maple, or any fruit tree, may be used. If a few limbs or trunks of newly felled trees be placed at intervals, say, of thirty or forty feet, on the outskirts of orchards, where they would be freely exposed to the sun, the beetles would be attracted for the deposition of their eggs, and all that would then be necessary would be to destroy the trap wood by burning before April or May of the following year. This plan has not been practically tested, but the writer has no doubt that it would prove useful in securing immunity from this pest in the orchard, provided that no diseased fruit trees be left for food.

*Cultural carefulness*—Careful, clean methods of cultivation are essential as a measure of protection, and involve the cutting out of dead, dying and injured deciduous forest and shade trees known to be chosen as food by this beetle, as well as orchard trees. Care should be exercised in transplanting, and especially in pruning, and the use of fertilizers should not be neglected, that the trees may be thrifty and better able to withstand attack. Proper regard for these measures should give practical exemption from injury.

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*C. V. Riley, Proc. Ent. Soc. Wash., Vol. III, p. 92.

†The list includes the Braconids, *Bracon charus* Riley and *B. pectinator* Say, *Spathius pallidus* Ashm., and the Ichneumonids, *Labena apicalis* Cr. and *L. grallator* Say, and one or more species of Chalcididæ, noticed by Fitch, as occurring in New York, and by Riley, in Missouri.

# OYSTER-SHELL SCALE.

(*Mytilaspis pomorum*, Bouche.)

By Prof. Alexander Craw.

This scale is very damaging to apple trees, and also infests other plants. The scale of the female is mussel shape, more or less curved, of a purplish-brown color, with the exuviæ yellowish. Length, one-sixteenth of an inch. The body of the female is light yellow. The last segment presents the following characteristics: The anterior group of spinnerets consists of from eleven to seventeen; the anterior laterals and posterior laterals each of sixteen to twenty-one. The median lobes are large and wide, with the sides parallel; they are only about three-fourths as long as broad. Each lobe is narrowed on each side near the distal extremity by one or two notches, and then rounded. The second lobe of each side is about as wide as the first, and is deeply incised; mesal lobule with mesal margin as long as lateral margin of the first lobe, and rounded posteriorly; lateral lobule about half the length and width of mesal lobule, and similar in shape. Third lobule obsolete. The plates are long, simple, and tapering.

*Eggs*—These are white, and are arranged irregularly under the scale.

*Scale of male*—The scale of the male of this species is usually straight and of the same color as that of the female. At about one quarter of the length of the scale from the posterior extremity the scale is thin, forming a hinge which allows the posterior part of it to be lifted by the male as he emerges. Length, six hundredths of an inch. The male is translucent, corneous gray, with a dorsal transverse band on each joint, and the portions of the mesothorax and metathorax darker, or purple gray, with the members somewhat lighter.

According to climate and locality the young scale hatch from the middle of March to June. Color, yellow. They begin to form the cottony excretion after twenty-four hours, and in two to four days the insect is completely covered with a dense excretion, which increases as the larva grows.

In several of the older apple-growing districts of the state this scale has secured a lodgment, and in neglected orchards that have been subdivided into city lots they have made considerable progress.

# THE PEAR-LEAF MITE.

By Prof. F. L. Washburn.

The affection of the pear leaf is caused by a minute mite, *Phytoptus pyri*, and is probably more common, and has been here longer, than most orchardists realize; in fact, it is very likely that much of that which has been called "blight" on the pear by casual observers, is really the work of this pest. The mite is very small, hardly visible to the naked eye, and is well represented in the accompnying micro-photograph furnished by Mr. Pernot.

It attacks both sides of the leaf, but individuals are more numerous on the under side where the small "blisters" can be seen with the naked eye. A lens, however, is required to show the opening in the center of the blister which serves as a doorway for the mite. The location of the injury below is made apparent on the upper surface of the leaf, by an irregular reddish spot, (in the early stages) which changes later to brown and black, while the tissue of the leaf between these two points, in which tissue eggs and young mites are found, becomes corky and dies.

The injury to the tree is more readily seen in the middle and late summer, when, in bad cases, almost its entire foliage looks blighted.

The young mites when hatched spread from leaf to leaf, creating new blisters and thus bringing about the condition referred to above. In the autumn, when leaves begin to wither and fall, the mites migrate to the twigs and hibernate beneath scales of bark or bud in the minute crevices on twigs, and in the spring they are fully open. It is hardly necessary to say that this mite saps the vitality of the tree, and interferes with the natural functions of the leaves. The work of this pest is illustrated by the accompanying full-page plate, showing views of upper and lower surfaces of leaves.

When a tree is observed to be first attacked pick off and burn the infected leaves. Heavy pruning and burning the cuttings of such trees as are badly affected, during the winter, will probably be more efficacious than anything else. One or two sprayings of kerosene emulsion in the antumn when mites are migrating would destroy many. The same spray, used several times, has been recommended for winter use. It is highly spoken of in a Cornell University bulletin, and is to be used in this proportion: One part emulsion to seven or eight parts of water.

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PS.—The best remedy for Oregon is sulphur, lime, and salt before the buds swell, followed by dusting with sulphur when leaves have formed.—Henry E. Dosch.

Leaves Affected with Pear Leaf Blister.

# THE CLOVER MITE.

(*Bryobia pratensis* Garman.)

By Prof. C. L. Marlatt.

### CHARACTERISTICS AND METHODS OF WORK.

The subject of this circular is a reddish-brown mite about twice the size of the ordinary red mite affecting greenhouse plants. It is nearly three-tenths of an inch in length, oval, and with remarkably long anterior legs. Other structural features, together with the peculiar hairs which clothe different parts of the body, are illustrated in the accompanying figure, which represents, much enlarged, the full-grown mite, viewed from above and from below.

This mite first came into prominence as a disagreeable invader of dwelling-houses about ten years since, but it had been known for a number of years earlier as an enemy of various fruit and shade trees and foliage plants, its occurrence on clover, particularly in the middle states, being indicated in its scientific name, *pratensis*, and its common name of clover mite. It belongs to the family of vegetable-feeding mites, Tetranychidæ, which includes such well-known depredators as the red spider of greenhouses, already referred to, and the six-spotted mite, which is quite troublesome to oranges in Florida. In California, where this plant mite is especially mischievous, it has been very generally confounded with the red spider, and in probably most of the references to injury to deciduous trees on the Pacific Coast by the "red spider" the real culprit is the insect under discussion.

The presence of this mite on foliage, either of clover or trees, causes the leaves to yellow or assume a sickly appearance, as if attacked by fungus. On the tender leaves of clover, notably on the upper sides, the juices are extracted, often over irregular, winding areas, imitating in appearance the burrows of certain leaf-mining larvæ. The most notable indication, however, of the presence of the mite is the occurrence of the eggs, massed often in such numbers as to completely cover the bark at the crotches and branches and sometimes over the entire surface of the trunk. These eggs are of rather large size and of a reddish color, and are conspicuous objects, and when numerous the decided color they impart to the bark leads to their ready discovery.

As out-of-doors enemies they are injurious at times to clover and other grasses, including the true grasses, as bluestem, but it is to fruit trees that their injuries are especially marked. Throughout the Pacific Coast, and in the fruit districts of Colorado and other western mountain states the clover mite is one of the principal enemies of such deciduous fruits as peach, prune, plum, apple, pear, almond, cherry, etc., and the poplar and elm, black locust,

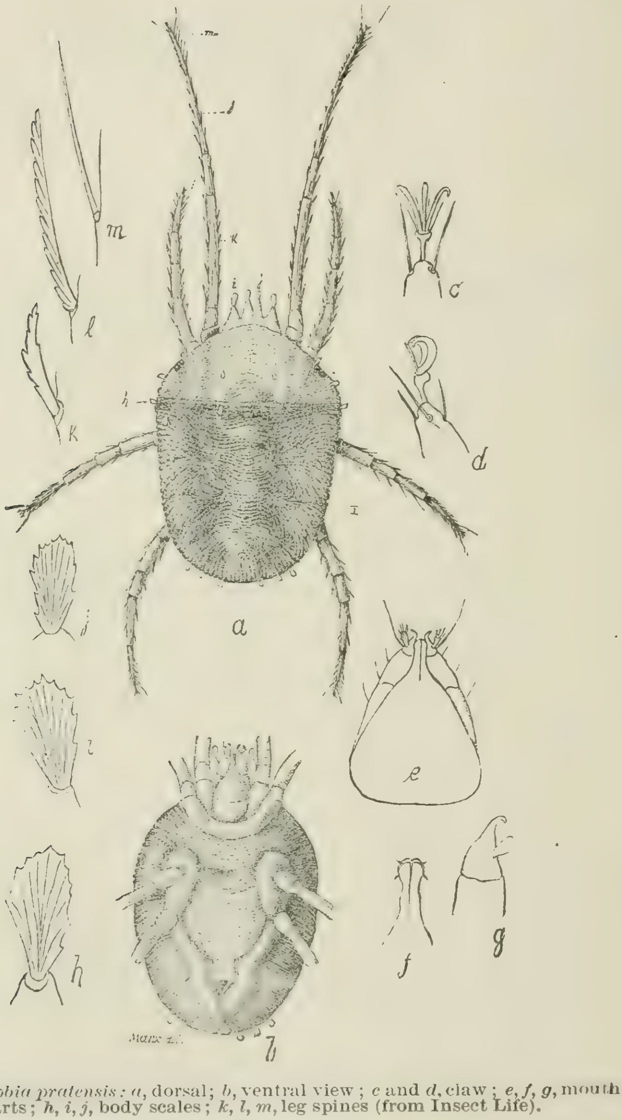



Fig. 1—*Bryobia pratensis*: *a*, dorsal; *b*, ventral view; *c* and *d*, claw; *e*, *f*, *g*, mouth-parts; *h*, *i*, *j*, body scales; *k*, *l*, *m*, leg spines (from Insect Life).

arbor vitæ, etc., among shade trees. As house pests they are troublesome from their presence merely in their efforts in the fall to find safe hibernating quarters and occasionally in their spring migrations in search of suitable breeding grounds.

### ORIGIN AND DISTRIBUTION.

Attention was first drawn to this mite in 1879, at Washington, D. C., from its occurrence on the trees in the department grounds and also on clover on lawns. It has since been reported from numerous localities, from Massachusetts to California. Northward it occurs in the east in northern New York and Canada. East of the Mississippi it has not been reported in the southern tier of states, the southernmost records occurring in Tennessee and North Carolina.

On the Pacific Coast it is known from San Diego, in California, to East Sound, in Washington; and at Las Cruces, New Mexico, it is a serious fruit pest. In the Sierra Nevada Mountains in California and in the Rocky Mountains in Montana it has been found at elevations of from seven thousand to eight thousand feet.

It is remarkable, therefore, for its ability to exist under marked differences of temperature and elevation. Its wide distribution and its occurrence in situations remote from settlement indicate that it is a native species. It was first characterized scientifically by H. Garman in 1885, who proposed for it the common and Latin name by which it is now known.

### HABITS AND LIFE-HISTORY.

The wide range of this insect and the different climatic conditions under which it exists lead, as might be expected, to certain variations in its life-history and habits in different localities. In the more northern regions of its occurrence and in the higher elevations it winters in the egg state, the last brood, if it may be so called, maturing in the fall, and depositing eggs on branches and trunks of trees sometimes in sufficient numbers to entirely cover the bark two or three layers deep. In 1889 we received a mass of these eggs several layers deep on a piece of bark which the sender states was from an area of at least fifty square feet of eggs on the south side of trunks of cottonwoods growing at an elevation of from six thousand to eight thousand feet. This was in the Sierra Nevada Mountains, Tuolumne County, California, and we have had a similar account, with specimens, from McCarthy Mountain, in Montana, at about the same elevation. In the middle and eastern states, where the eggs are frequently found on fruit trees, they are usually confined to the crotches and branches and are not nearly so abundant.

In the colder regions, where the winter is passed in the egg state, the issuance of the young mites the following spring varies from May until the middle of June, depending on the character of the season. In the warmer regions—as, for instance, in the latitude of Washington—the mites begin to be noticeable on foliage and grass in May or earlier, and enter their hibernating quarters early in October, in crevices of fences or walls or under the

loose bark of various trees. It is seen, therefore, that in the warmer localities breeding is hardly interrupted during the winter months and the winter is passed quite as much in the active as in the egg state. Throughout the summer young are produced continuously, as with most other plant mites, with no particular differentiation of broods.

The habit of this mite of abandoning its feeding situations in the fall to seek hibernating quarters elsewhere leads to its being a house pest of no mean importance. This is particularly true wherever it has been breeding on clover or other grasses near dwellings. From such situations, particularly in the Mississippi Valley States, it often swarms into dwellings through doors or windows, its small size enabling it to penetrate wire screens with ease to the very considerable disquietude of the housekeeper. There are only a few records of their entering houses in the east. and in the extreme west they seem only to have been found on trees.

### REMEDIES AND PREVENTIVES.

The protection of fruit trees from the attacks of this mite is comparatively easy where the winter is chiefly passed in the egg state, as in Colorado or other elevated or cold districts. The experience of Mr. C. P. Gillette in Colorado has shown that the eggs may be very easily destroyed during winter by applying kerosene emulsion to the trees at about twice the ordinary strength, viz, diluted with five parts of water. Spraying at this time is both economical and easy, on account of the absence of foliage, and no danger will result to the plants from the application. Such an application also in the warmer latitudes will be of almost equal value as a protection to fruit trees, since it will reach what eggs there may be and also many of the mites secreted in the cracks of the bark.

It is a much more difficult matter to protect clover and other grasses from the mites, except as it may be possible to spray in winter the trees, fences, etc., on or in which the mites may be hibernating, in the vicinity of lawns.

Their entrance into houses in fall my be prevented by spraying the lower portion of the building, walls, etc., with pure kerosene as often as need be and also spraying the lawns immediately about the building with kerosene emulsion nine times diluted. The mites may be destroyed after they have gained entrance to the house by the free use of buhach or pyrethrum powder, burning brimstone, or spraying with benzine. taking due precautions with the latter substance in the matter of fire.

# THE SAN JOSE SCALE.

By Profs. L. O. Howard and C. L. Marlatt.

## HABITS AND LIFE-HISTORY.

### NATURE OF THE DAMAGE.

The San Jose scale, as already stated, occurs on all parts of the plant, limbs, leaves, and fruit. As the plant becomes badly infested the scales lie very close together on the limbs, frequently overlapping, sometimes with several young ones clustering over the surface of an old mature scale. The general appearance which they present is of a grayish, very slightly roughened, scurfy deposit. The natural rich reddish color of the young limbs of peach, pear, and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with ashes. When the scales are crushed by scraping, a yellowish, oily liquid will appear, resulting from the mashing of the soft yellow insects beneath the scales. Examined under a hand lens during the summer numbers of the little orange-colored larvæ will be seen running about, and the snowy white young scales will be interspersed with old brown or blackened mature scales. The appearance presented at this time under the lens is shown in the frontispiece and still more satisfactorily in the accompanying figure (Fig. 2). Very frequently the scale has a marked tendency to infest the extremities of the branches and twigs. This is particularly noticeable with pear. As usually found on peach the sale is massed often more densely on the older growth and works out more slowly toward the new wood.

The leaves are much less apt to bear scales, but in severe cases the upper surface particularly becomes infested, the scales frequently ranging in two or more quite regular rows on either side of the midrib. The male scales are more numerous on the leaves than the females. The infested leaves turn purplish brown.

The San Jose scale was formerly supposed to differ from all others in the peculiar reddening effect which it produces upon the skin of the fruit and of tender twigs. This, however, sometimes occurs with other scales, but is a particularly characteristic feature of this insect, and renders it easy to distinguish. The encircling band of reddish discoloration around the margin of each female scale is very noticeable on fruit, especially pears. This appearance, however, sometimes so closely resembles the small spots on fruit produced by a common fungus, *Entomosporium maculatum* Lev., as to require close examination with a lens to distinguish it. Fruit severely attacked becomes distorted, rough, and pitted, frequently cracking, and may eventually fall prematurely, or at least become unmarketable.

The cambium layer of young twigs where the scales are massed together

is usually stained deep red or purplish, and when the scale is only scatteringly present the distinctive purplish ring surrounding each is almost as noticeable on young twigs as on fruit, and is of the greatest service in facilitating the inspection of trees which have been subject to possible contagion. The almost microscopic young scale might easily elude the most careful search, but the striking circling ring makes them comparatively conspicuous objects without the aid of a glass.


Fig. 2—Appearance of scale on bark: *a*, infested twig, natural size; *b*, bark as it appears under hand lens showing scales in various stages of development and young larvæ. (Original).

If the tree survives the attack the infested wood eventually becomes knotty and irregular, partly from the sapping of the juices by the insect and also without doubt largely from the poisoning of the sap of the cambium layer by the punctures of the insect, as indicated by the discoloration. Young peach trees will ordinarily survive the scale only two or three years. Pears are sometimes killed outright, but generally maintain a feeble, sickly existence, making little or no growth for a somewhat longer period.

## FOOD PLANTS.

Practically all deciduous fruit trees are subject to the attacks of this insect, including also various small fruits, such as the currant, gooseberry, etc. It has also been found on a great many shade trees and ornamental shrubs. The pear, peach, plum, apple, and cherry are almost equally liable to injury. The quince is apparently more rarely troubled. Notwithstanding its wide range of food plants, certain varieties of pear, strangely enough, seem to be almost never attacked, if not entirely exempt. This holds, also, to a less extent, with the different varieties of other fruits. Professor Smith says of plums that apparently Japanese varieties are favorities, while those of American and European origin suffer much less. The notable exceptions are, however, found in the case of pears. This is strikingly exhibited with the Leconte and Kieffer varieties, which are almost exempt.* A notable instance of the latter is the case of a tree which bore both Lawson and Kieffer grafts. The Lawson branch, leaves, and fruit was entirely covered, while the Kieffer portion was entirely free from the scale. No other variety of pear has been found equal to the Leconte and Kieffer in immunity. The following list of food plants is substantially as compiled by Doctor Lintner:

*Tiliaceæ:*
Linden.
*Celastraceæ:*
Euonymus.
*Rosaceæ:*
Almond.
Peach.
Apricot.
Plum.
Cherry.
Spiræa.
Raspberry.
Rose.
Hawthorn.
Cotoneaster.
Pear.
Apple.
Quince.
Flowering quince.
*Saxifragaceæ:*
Gooseberry.
Currant.
Flowering currant.
*Ebenaceæ:*
Persimmon.
*Leguminosæ:*
Acacia.
*Urticaceæ:*
Elm.
Osage orange.
*Juglandaceæ:*
English walnut.
Pecan.
*Betulaceæ:*
Alder?
*Salicaceæ:*
Weeping willow.
Laurel-leaved willow (from Asia.)

## LIFE-HISTORY.

In common with all the armored scales, the life-round of this insect, with the exception of a few hours of active larval existence and an equally brief winged existence in the case of the mature male, is passed under the protection of a waxy scale. This scale covering conceals the real insect beneath and prevents any easy observation or study of its life-history. The San Jose scale has been under the most careful observation by Mr. Pergande on potted plants in the insectary, and its history, which has hitherto been very imperfectly worked out, has been thoroughly and carefully elaborated.

The winter is passed by the nearly full-grown insects under the protection of the scale. Early in April in this latitude the hibernating males emerge, and by the middle of May the overwintered females mature and begin to give birth to a new generation, continuing to produce young for a period of upward of six weeks, when they reach the limit of protection of young and perish.

*Mr. Charles Parry has recently observed cases in which both Kieffer and Leconte pears have been badly damaged.

The adult female gives birth immediately to living young, differing in this respect from most other scale insects. Ordinarily eggs are deposited beneath the scale, which in the course of a longer or shorter time hatch, and the young larvæ make their escape and migrate to different parts of the plant. In the case of some scale insects the female fills its scale with eggs in the fall and perishes, the eggs wintering over and hatching the following spring. In others the insect hibernates in the nearly mature condition, as does the San Jose scale, and deposits eggs in the spring or early summer. The viviparous habit, or the giving birth to the living young, possessed by the San Jose scale, finds a parallel in many other insects and frequently in plant-lice. In the case of the San Jose scale the eggs are fairly well formed.

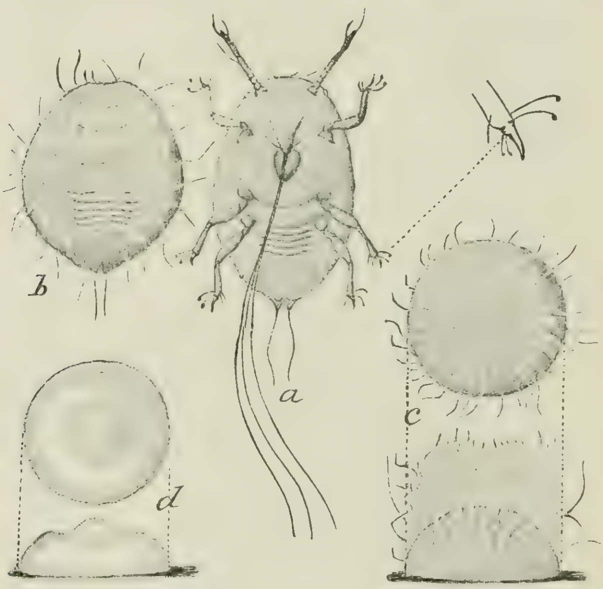



Fig. 3—Young larva and developing scale: *a*, ventral view of larva, showing sucking beak with setæ separated, with enlarged tarsal claw at right; *b*, dorsal view of same, somewhat contracted, with the first waxy filaments appearing; *c*, dorsal and lateral views of same, still more contracted, illustrating further development of wax secretion; *d*, later stage of same, dorsal and lateral views, showing matting of wax secretions and first form of young scale—all greatly enlarged. (Original.)

a few at a time, within the body of the mother. What takes the place of the eggshell consists of a very delicate and thin membrane—the amnion—which incloses the developing larvæ and which at the moment of birth is cast off, and remains attached to or partly within the oviduct. The amnion is probably pushed out by the next larva in turn. The difference between this mode of birth and the ordinary method through the medium of true eggs is simply that what corresponds with the egg is retained by the female until the larva is developed, instead of development of the larva progressing after the egg leaves the parent.

The emergence of the young from the female over a period of six weeks leads to a very confusing intermingling of generations and renders it difficult to make observations on the life-history except by isolating and watching individuals. By means of such isolation of individuals, however, we have been able to most carefully trace the different generations. The course of the development of a single generation follows:

After being expelled the larva remains motionless for a little while, with antennæ and legs folded beneath the body. It soon hardens enough to run about, and forcing its way out from beneath the protecting scale of the mother, scurries over the plant to find a suitable place to settle.

The newly born larva (Fig. 3, *a*) is an almost microscopic creature of pale orange-yellow color, with long oval body, and with the customary six legs and two feelers. The long thread-like proboscis with which the juices of the plant are sucked up is doubled on itself and lies in an invagination of the body wall, the tip only projecting.

After crawling about for a few hours, the young larva settles down and slowly works its long bristle-like sucking beak through the bark, folds its antennæ and legs beneath its body and contracts to a nearly circular form. The development of the scale begins even before the larva becomes fixed. The secretion starts in the form of very minute white fibrous waxy filaments, which spring from all parts of the body and rapidly become more numerous and dense (Fig. 3 *b*, *c*). At first the orange color of the larva shows through the thickening downy white envelope, but within two days the insect becomes entirely concealed by the white or pale grayish yellow shell or scale, which now has a prominent central nipple (Fig. 3, *d*), the younger ones often possessing instead a central tuft. The scale is formed by the slow matting and melting together of the filaments of wax. During the first day the scale appears like a very microscopic downy hemisphere. The matting of the secretion continues until the appearance of down and individual filaments is entirely lost and the surface becomes smooth. In the early history of the scale it maintains its pale whitish or grayish yellow color, turning gradually darker gray, the central nipple remaining lighter colored usually throughout development.

The male and female scales are exactly similar in size, color, and shape until after the first molt, which occurs twelve days after the emergence of the larva. With this molt, however, the insects beneath the scale lose all resemblance to each other. The males (Fig. 4, *a*) are rather larger than the females, and have large purple eyes, while the females have lost their eyes entirely. The legs and antennæ have disappeared in both sexes. The males are elongate and pyriform, while the females are almost circular, amounting practically to a flattened sac with indistinct segmentation, and without organs, except a long sucking bristle springing from near the center beneath. The color of both sexes is light lemon yellow. The scales at this time have a decidedly grayish tint, overcast somewhat with yellow.

Eighteen days from birth the males change to the first pupal condition (pro-pupa), (Fig. 4, *b*) and the male scales assume an elongate oval, sometimes slightly curved shape, characteristic of the sex, the exuvia or cast larval skin showing near the anterior end.

The male pro-pupæ are very pale yellow, with the legs and antennæ (which have reappeared) together with the two or three terminal segments colorless. The eyes are dark purple and placed close together. The antennæ are stout and built closely along the edge of the body as far as the first pair of legs, where they curve slightly inward. Prominent wing-pads extending along the side of the body. The terminal segment bears two short spines.

The female undergoes a second molt about twenty days from the larva. At each molt the old skin splits around the edge of the body, the upper half adhering to the covering scale and the lower forming a sort of ventral scale next to the bark. This form of molting is common to scales of this kind.

The covering scales at this stage are of a more purplish gray, the portion covering the exuviæ inclining to yellowish. The male scales are more yellowish than the female. The effect of the sucking of the insects is now quite apparent on the young growth, causing the bark to assume a purplish hue for some distance around the cental portion, contrasting strongly with the

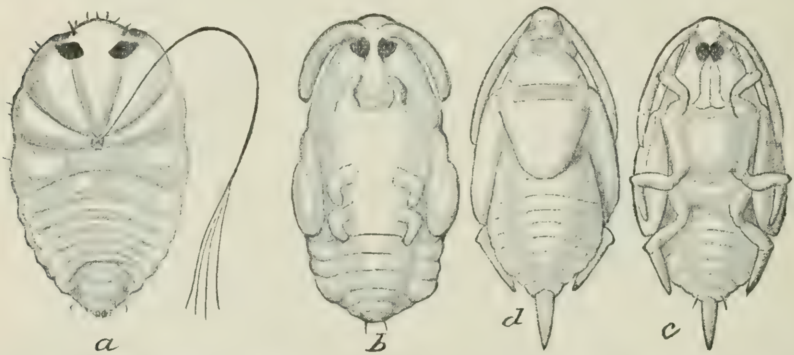



Fig. 4—Development of male insect; *a*, ventral view of larva after first molt; *b*, same, after second molt (pro-pupa stage); *c* and *d*, true pupa, ventral and dorsal views. All greatly enlarged. (Original).

natural reddish green of the uninjured bark. With the second molt the females do not change materially from their former appearance, retaining the pale yellow color with a number of transparent spots around the edge of the body. The sucking bristles are extremely long, two or three times the length of the body of the insect. The only distinctive features are in the last segment and are noted in the technical description.

About twenty days after birth the male insect transforms to the true pupa. With the first molt the shed larval skin is retained beneath the scale as in the case of the female; with the latter moltings the shed skins are pushed out from beneath the scale. The scale, after the second molt, presents on the inside two longitudinal ridges running from one end to the other, touching the sides of the pupa, and which apparently enable the insect to move backward or forward and assist the imago in pushing itself out.

The true pupa (Fig. 4 *c*, *d*) is pale yellow, sometimes purplish, darkest about the base of the abdomen. The head, antennæ, legs, wing-pads, and style are well formed, but almost colorless. The antennæ reach as far back

as the second pair of legs and are not curved under, as formerly, but lie close to the side of the body with the ends free. The first pair of legs are held forward, reaching slightly beyond the eyes, the middle femora projecting somewhat beyond the margin of the abdomen. The hind legs are inclined backward and reach to the end of the body. The style is rounded at tip, conical, and about as long as the posterior tibiæ.

From four to six days later, or from twenty-four to twenty-six days from birth, the males mature and back out from the rear end of their scales, having previously, for a day or two, remained practically developed but resting under the scale. They seem to issue chiefly by night or in the evening.

The mature male (Fig. 5) appears as a delicate two-winged fly-like insects with long feelers and a single anal style projecting from the end of the body; orange in color, with a faintly dusky shade on the prothorax. The head is

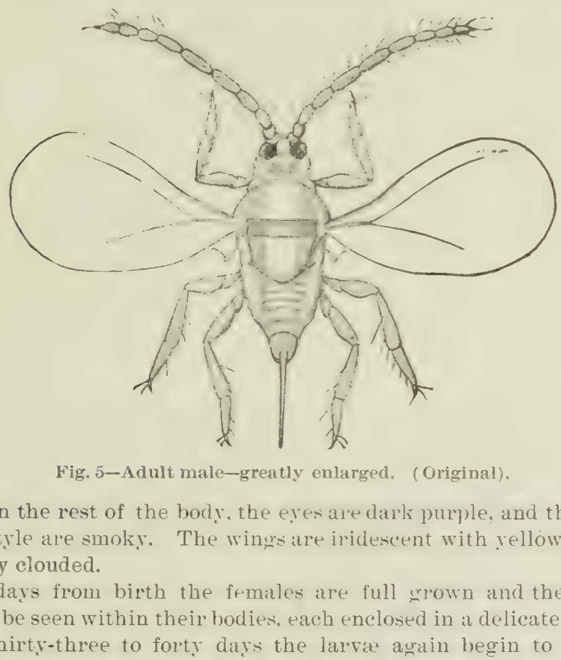


Fig. 5—Adult male—greatly enlarged. (Original).

darker than the rest of the body, the eyes are dark purple, and the antennæ, legs, and style are smoky. The wings are iridescent with yellow and green, very faintly clouded.

Thirty days from birth the females are full grown and the embryonic young may be seen within their bodies, each enclosed in a delicate membrane. At from thirty-three to forty days the larvæ again begin to make their appearance.

The adult female, prior to the development of the young, measures one millimeter in length and a little less in breadth, and is pale yellow with transparent spots near the margin of the body (Fig. 6).

The length of a generation is determined by the female, and as shown by the above record, covers a period of from thirty-three to forty days. Successive generations were followed carefully throughout the summer, and it was found that at Washington four full generations are regularly developed, with the possibility of a partial fifth generation. On a number of potted trees a single overwintered female was left to each tree. After the full

progeny of this individual had gone out over the tree, all were removed

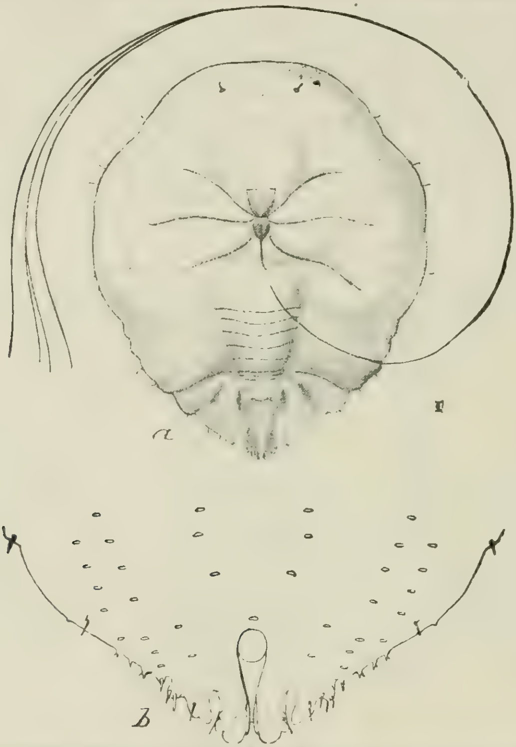


Fig. 6—Adult female, before development of eggs; *a*, ventral view, showing very long sucking setæ; *b*, anal plate, showing characteristic ornamentation of edge—greatly enlarged. (Original).

again, except one of the oldest and fertilized females. This method was continued for each generation throughout the breeding season. Some interesting records, tabulated below, were thus obtained, which indicate the fecundity of the females as well as the number of generations:

| *Number of tree.* | *Males.* | *Females.* | *Total.* | *Number of tree.* | *Males.* | *Females.* | *Total.* |
|---|---|---|---|---|---|---|---|
| | *Progeny of overwintered females.* | | | | *Progeny of third generation.* | | |
| 1 | 72 | 34 | 106 | 1 | 110 | 307 | 417 |
| 2 | 77 | 43 | 120 | 2 | 122 | 464 | 586 |
| 3 | 138 | 60 | 198 | 3 | 190 | 284 | 474 |
| 4 | 18 | 22 | 40 | 4 | 187 | 400 | 587 |
| 5 | 98 | 60 | 158 | 5 | 174 | 280 | 454 |
| 6 | 33 | 25 | 58 | 6 | 107 | 274 | 354 |
| 7 | 13 | ---- | 13 | | *Progeny of fourth generation.* | | |
| | *Progeny of second generation.* | | | 1 | 242 | 319 | 561 |
| 1 | 350 | 235 | 585 | 2 | 112 | 230 | 342 |
| 2 | 276 | 226 | 502 | 3 | 92 | 170 | 262 |
| 3 | 325 | 92 | 417 | 4 | 210 | 344 | 554 |
| 4 | 192 | 120 | 312 | 5 | 242 | 343 | 585 |
| 5 | 415 | 151 | 556 | 6 | 156 | 293 | 449 |
| 6 | 206 | 124 | 330 | | | | |

Perhaps the most notable feature of the foregoing record is the result obtained from the overwintered females. It will be seen that the males greatly predominate in this generation, and that the numbers of both sexes are insignificant compared with the progeny of the later generations. The males still predominate in the second generation, but in the third and fourth generations the females considerably outnumber the males, in one instance the females from a single mother reaching the astonishing number of four hundred and sixty-four, which, with one hundred and twenty-two males from the same parent, makes the progeny of this female five hundred and eighty-six insects. Taking two hundred females as an average of the different generations for the year, the product of a single individual from spring to fall amounts to one billion six hundred and eight million forty thousand two hundred females. In one instance we have over four hundred and fifteen males from a single female, and while the number of males would average somewhat less than the females, taking the summer through, yet, having underestimated the females, the males may be estimated at the same number, giving a total of three billion two hundred and sixteen million eighty thousand four hundred descendants from a single insect in a single season. It is not to be expected, of course, that all the individuals from a scale survive and perform their function in life, but under favorable conditions, or in the case of a tree newly infested or not heavily incrusted, the vast majority undoubtedly go through their existence without accident. Neither the rapidity with which trees become infested nor the fatal effect which so early follows the appearance of this scale insect is therefore to be wondered at.

Owing to the long period during which the female is continuously producing young, the different generations or broods in the course of the summer are not distinctly marked and merge insensibly into each other so much so that at almost any time there will be found young larvæ running about over the trees and scales in all stages of development. Still at certain times the young will be noticeably more abundant, indicating periods when the majority of each generation are producing young. In this latitude the first young appear, as noted, by the middle of May, at Armherst, Massachusetts, they were first noticed June 12, and in Arizona they are recorded as appearing in March. The larvæ are continuously present on the trees until further hatching is prevented by severe frosts. In 1894, as we have already shown on page 289 of Volume VII of Insect Life, the first frosts at Washington occurred in the latter part of October and the hatching of the young ceased before the first of November. October 24, 1894, however, Mr. Howard saw recently settled larvæ, not more than five days old, at Lewisburg, Pennsylvania. In 1895, the October frosts were insignificant, and in this neighborhood no severe frosts occurred until about the first of December. The result was that young larvæ were found at Washington until late in November, while on twigs received from Chestertown, Maryland, November 13 and November 27, the young were more or less abundant. The cold spell of the last week in November and the first week in December put a stop to development here. This same cold spell was of very wide extent. As far

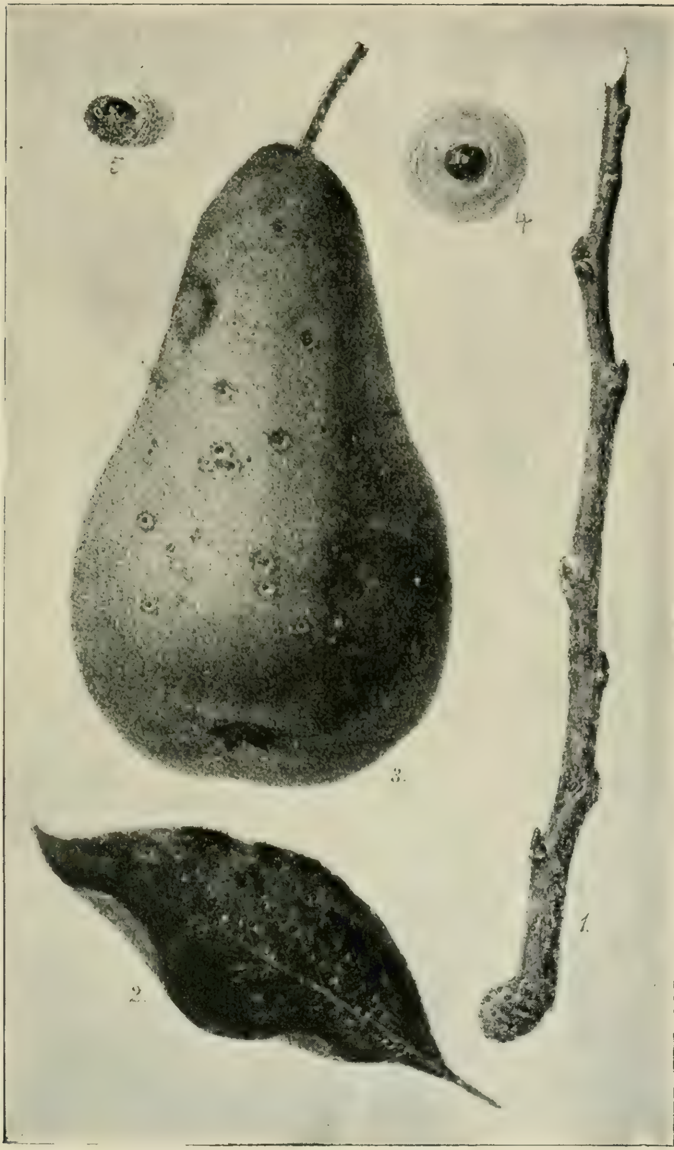
to the southwest as San Antonio, Texas, the thermometer dropped to 31° on December 3. A similar, or even lower, temperature was noted at New Orleans, yet, on December 16, Mr. Howard found newly hatched young, less than twenty-four hours old, upon a plum tree at Audubon Park, New Orleans.

In autumn, or when further development is stopped by cold weather, hibernation is begun by scales in all stages of development, from the white, minute, down-covered recently hatched young to the mature and full-grown females and males. Unquestionably many young perish during the winter, and normally in spring quite a percentage of the smaller or half-grown scales will be found to have perished. It is very probable that many females have union with the males in the fall, but the majority of them are unquestionably immature, and are fertilized in this latitude early in April by overwintered males which, as we have noted, appear nearly a month before the first of the young spring brood.

The actual rate of the production of young at different periods of the life of the adult female has not been determined with accuracy. As the average reproducing period of the adult female is six weeks, and as the average number of young from each female is about four hundred, there must be born from nine to ten young every twenty-four hours. The great labor of watching an individual female and removing every twenty-four hours the young she has given birth to during that period has not been entered upon. Sufficient observations have been made, however, to indicate that the main period of reproductive activity is the second or third week after the female has reached maturity. At first the young are born with less frequency, and there is a corresponding reduction in reproductive activity toward the end of the life of the individual. The young are born indifferently by day or by night, perhaps more during the day than during the night. In the morning, however, examination of the trees under observation always shows many migrating young which must have been born during the night, while observations at nightfall show always as many, and freqnently more, which have been born during the day.

The gradual production of the young by the female has an important bearing on the question of remedies, and the old washes, which aimed at the destruction of the young as soon as they emerge from the females, are rendered almost valueless because, to make them effective, it is necessary to repeat them many times during a period of six weeks. Within two or three days after hatching the young larvæ will have formed a scale which will be impervious to these weaker washes.

The larva does not ordinarily travel far from the parent insect, and usually rests within a few inches of the old scale or at the first available point. They will not, so far as observed, travel very far from the base of the tree, and in the potted trees none were observed to go more than two inches from the base of the trunk.




THE SAN JOSE SCALE.

1, Infested branch; 2, infested leaf; 3, pear, bearing a few of the scales; 4, female scale—enlarged; 5, male scale—enlarged. (Adopted from report of W. G. Klee, 3d Rept., Cal. Bd. Hort.)

DESCRIPTION OF SCALE AND INSECT.

*Scale of female*—The scale of the female is circular, very slightly raised centrally, and varies in diameter from one to two millimeters, averaging about one and four-tenths millimeters. The exuviæ is central or nearly so. The large, well-developed scales are gray, excepting the central part covering the exuviæ which varies from pale to reddish yellow, although in some cases dark colored. The scale is usually smooth exteriorly or sometimes slightly annulated, and the limits of the larval scale are always plainly marked. The natural color of the scale is frequently obscured by the presence of the sooty fungus (*Fumago salicina*).

*Scale of male*—The mature male scale is oblong oval, nearly twice as long as wide, and averaging in length about half the diameter of the female scale. The position of the larval scale is marked by a nipple-like prominence located between the center and the anterior margin of the scale. The scale of the male is usually darker than of the female, sometimes black, but often gray, the larval scale covering the exuviæ very frequently light yellow as with the female. Not uncommonly the circular scale, formed prior to the first molt, is black, while the later additions, giving it its oblong shape, are gray.

*Egg*—The egg is never (or rarely) extruded as such by the female, and as it exists within the body of the mother is a mere amniotic membrane, and the forming embryo showing through gives it a yellowish white color. The embryo with the envelope measures about two-tenths of a millimeter long by one-tenth of a millimeter wide.

*Newly hatched larva*—The young larvæ of both sexes are alike, and are pale orange in color, with long oval bodies. They measure in length about twenty-four hundredths of a millimeter by one-tenth of a millimeter in width. The sucking bristles are normally doubled on themselves, but when unfolded are nearly three times the length of the body. The antennæ are apparently five-jointed, the last two joints being much longer than the others, slender, subequal in length, and both finely and distinctly annulated. The last joint bears a small nipple-like joint near the tip. The head is somewhat concave in front, and the eyes are nearly transparent and slightly purplish. The terminal segment of the abdomen foreshadows in structure the plates and spines of the adult female. The large central plates each terminate in a long hair. The tarsus is represented by apparently a single, strong, slightly curved claw. The tip of the tibia bears exteriorly two rather long capitate hairs, and two similar hairs project also from the inner extremity. Other details of structure are shown in the illustration.

*Larva of the second stage*—After the first molt the difference in the sexes becomes apparent, although the covering scales are still identical.

The female insects are somewhat smaller than the males at this stage. The eyes, legs, and antennæ in this sex have entirely disappeared. The form is almost circular, flattened. The color is yellow with irregular transparent spots appearing in different parts of the body.

The males are somewhat larger than the females, elongate, pyriform. The eyes are prominent, purple in color. The legs and antennæ, as with the females, are wanting. The general color of the body is yellow, with the

irregular transparent spots noted in the case of the female. The greatest diameter in both sexes is less than one-half a millimeter, and in the characteristics of the terminal segment both agree, practically, with the adult female.

*Male pro-pupa*—With the second molt the male assumes a form foreshadowing the true pupa, which may be called the pro-pupa.* The form is elongate oval; length five-tenths of a millimeter. The color is very pale yellow, with the antennæ, limbs, and wingpad, and two or three terminal segments of the abdomen, colorless. The legs and antennæ, as noted, have reappeared, and also prominent pads foreshadowing the wings of adult. The eyes are dark purple and placed close together. The antennæ are very stout and curved closely around the edge of the body as far as the anterior legs, where they bend inward. The wingpads are stout and almost entirely cover the abdomen. The terminal segment is still broad and flattened and bears two short spines, but the other characters have disappeared.

*True pupa of male*—The true pupa resembles the previous stage, except that the members are longer and slenderer, and the prominent anal style has appeared. The pupa is pale yellow and purplish in color, darkest about the base of the abdomen, the head, antennæ, legs, wing sheaths, and style being almost colorless and transparent. The eye spots are dark purple. The antennæ extend nearly to the middle femora, and are not curved under the body as formerly, but are applied close to the sides, with the apex free. The anterior legs are held forward, reaching slightly beyond the eyes. The middle femora rests transversely to the body, projecting somewhat beyond the margin of the abdomen, while their tibiæ form with them a right angle, and reach nearly to the apex of the hind femora. The latter incline posteriorly, while the hind tibiæ are applied close to the sides of the body, except toward the tip, and reach nearly to the base of the style. The style is rather stout, conical, obtusely pointed at tip, and about as long as posterior tibiæ. Length, eight tenths of a millimeter, including style, which measures about fifteen-hundredths of a millimeter.

*Mature male*—The general color is orange with a faint duskiness on the prothorax. The head is somewhat darker than the rest of the body. The eyes are dark purple, almost black. The antennæ are yellow, somewhat obscure or smoky. The legs and style are dusky, the latter paler than the former. The thoracic shield is regularly ovoid, compressed anteriorly, dusky in color, with margin brown, more distinctly so anteriorly; transverse band narrow, brown. Antennæ ten-jointed, two basal joints shortest, second nearly globular, inserted in the first; joints four and five subequal, longer than any of the others; joint six next in length, and joints three, seven, and nine shorter and subequal; joint ten still shorter, conical. Antennæ somewhat hairy and nearly as long as the body of the insect. Wings, faintly dusky, iridescent with yellow and green. Length of body about six-tenths of a millimeter; style twenty-five one-hundredths of a millimeter.

*The existence of a pro-pupa or a first pupal stage in the Coccidæ analogous to the first pupal stage of higher Hemiptera has also been affirmed by Dr. Fr. Loew (*Weiner Entom. Zeit.*, Jan. 1884, p. 13).

*Female, third stage.* After the second molt the females still appear pale yellow as before, with various larger and smaller transparent spots around the border of the body. The form is nearly circular with greatest diameter averaging fifty-six one-hundredths of a millimeter. The sucking bristles are very prominent and long, three times the length of the insect. The last segment in this stage has practically the characters of the mature female, as follows: There are two pairs of lobes, the terminal ones largest and nearly three times as broad as the other lobes. Terminal lobes are rounded at the apex and are distinctly notched near the middle of the external edge. The second pair of lobes is smaller and narrower and is also notched externally. Between the first and second lobe on either side is a small spine and two or three such spines are just back of the second lobe, while back of these are three stout teeth, curving anteriorly. A still smaller blunt tooth sometimes occurs near the middle of the lateral margin. The segmentation of the body at this stage is quite distinct.

*Mature female.* After reaching maturity the embryonic young are at first not visible, but later the body becomes filled with them. The mature female measures eight-tenths of a millimeter wide by about one millimeter long.*

The following description of this stage is reproduced from Comstock:

"The body of the female is yellowish and almost circular in outline; the segmentation is distinct, though not conspicuous. The last segment presents the following characters:

"There are only two pairs of lobes visible: the first pair converges at tip, are notched about midway their length on the lateral margin, and often bear a slight notch on the mesal margin near the tip. The second pair are notched once on the lateral margin.

"The margin of the ventral surface of the segment is deeply incised twice on each side of the meson: once between the bases of the first and second lobes and again laterad of the second lobe. On each side of each of these incisions is a club-shaped thickening of the body wall.

"There are two inconspicuous simple plates between the median lobes, and on each side similar plates extending caudad of the first incision, three small plates serrate on their lateral margin caudad of the second incision, and the club-shaped thickening of the body wall bounding it, and three wide prolongations of the margin between the third and fourth spines. These prolongations are usually fringed on their distal margins. There are also, in some, irregular prolongations of the margin between the fourth spine and the penultimate segment.

"The first and second spines are situated laterad of the first and second lobes, respectively; the third spine laterad of second incision; and the fourth spine about one-half the distance from the fourth lobe to the penultimate segment."

## MEANS OF DISTRIBUTION.

From an economic standpoint, the important considerations in the means of spread of this insect are those which affect its wide distribution from one part of the country to another. The transportation by nursery stock or scions, or budding and grafting material, as indicated in the foregoing account of this insect, is unquestionably the usual and principal means of

*Rept. U. S. Dept. Agric., 1880, p. 304.

carrying the insect to a distance. The importance of this means of distributing various insects has only been fully realized in this country in the last few years, but the present instance and some other notable ones of like nature have emphasized the great danger incurred not only in the indiscriminate introduction of plants from foreign sources, but also in the carriage of plants from one part of the country to another without competent inspection. The San Jose scale is also frequently carried about on fruit, as the young very commonly crawl out upon the fruit, particularly with the pear, and is thus shipped to remote points. It may be frequently thrown out on parings and the young larva may gain access in this way to trees. This method of transportation was strikingly illustrated at the meeting of the Association of Economic Entomologists held in Brooklyn in 1894, when Prof. J. B. Smith exhibited a number of California pears purchased from the nearest fruit stand, all of which were badly infested with the scale, showing many full-grown females, and, in some cases, young larvæ crawling about. Such fruit is sold on all trains and in practically all large towns in the United States. Prof. J. W. Toumey states (Bulletin 14, Arizona Experiment Station, p. 35) that he has purchased California pears and apples in the fruit stalls of Phoenix and Tucson infested with both female and male scales, and Professor Smith reports a like experience in the markets of Philadelphia, Newark, New York, and Brooklyn. The danger of infestation from parings and rejected fruit will, therefore, be easily understood.

The spread of the insect from orchard to orchard and from tree to tree must also be brought about through the agency of means other than those under the control of the insect itself. The female is wingless, and after once becoming fixed can not move. The young lice, as before stated, are active, crawl rapidly, and may reach other trees, but this is rare unless the limbs interlace, since we have shown by breeding-cage experiments that the larvæ normally crawl but a few inches. Such spread, however, is comparatively insignificant except in the case of nursery stock, which is grown close together. It is possible that strong winds may carry the young bodily from one tree to another, or, they may be floated on water to distant points, particularly in irrigated districts, but the principal method of the spread of these young lice is by means of other insects, and by birds. The active young lice soon crawl upon any small winged insect, particularly if the latter be of a dark color, and may thus be carried considerable distances. They are frequently found crawling upon ants, which are great travelers. It is extremely probable that they also crawl upon the feet of birds, and may be transported by these carriers for many miles.

Some interesting observations have been made by Mr. Schwarz upon the transporting of these scale larvæ by other insects. A little black ladybird, *Pentilia misella*, which was very active in devouring scale larvæ, was unfortunately equally efficient in transporting many of these young lice to other parts of the tree or to other trees; in fact, it was difficult to find a single beetle which did not carry on its back at least one larva of the San Jose scale, and sometimes three or four were found upon a single wing-cover of a beetle. The small black ant, *Monomorium minutum*, was particularly

abundant upon pears, attracted by the juices emerging from cracks, and almost every one of these insects carried on its back one or more specimens of the young scale insects. Specimens of the little chrysomelid beetle, *Typophorus canellus*, were also found upon the trees. Both red and black specimens of this beetle occurred, and the interesting observation was made that while Aspidiotus larvæ crawled freely on the black individuals no specimens were to be found upon the red ones. The same peculiarity was found to hold true with the ants. The red ant, *Formica schaufussi*, was abundant upon the pears but no specimens were found bearing Aspidiotus larvæ, while, as just stated, the little black Monomorium was always found carrying them.

As illustrating this transportation of the scale by birds or insects the experience at Riverside, Maryland (ante, p. 25), may be cited, and Professor Smith reports a similar instance in New Jersey, in letter of January 13, 1896.

In spite of the abundance of insects which may transport the larvæ the progress of the scale from infested trees to noninfested trees is slow where trees are moderately widely separated, and usually an entire orchard will not become affected from a single original point for several years.

Occasionally the young scales may be locally transported by men or teams. An interesting case in point is given by Professor Rolfs. He states that some melons growing in an infested orchard were given by the owner to a friend, who took them away from the orchard in his wagon. A year later the scale developed on a tree under which the team had been hitched while the melons were unloaded. As this orchard was entirely free from the scale originally it seems to be a reasonable inference that the young had crawled upon the wagon, harness, or melons, were conveyed a distance of three miles, and succeeded in gaining access to a tree which probably touched the wagon or team during the interval of unloading.

## THE PARASITES AND NATURAL ENEMIES.

### TRUE PARASITES.

Of true parasites three have been reared from the San Jose scale in California and three in the east, two of the latter being the same as two of those occurring on the Pacific Slope. The most important parasite perhaps is *Aphelinus fuscipennis* How., a common and widespread enemy of armored scales. The general characteristics of *fuscipennis* are well shown in the accompanying figure of a closely allied species (Fig. 7). This parasite has been reared in large numbers by Mr. Coquillett in California, where he found it to breed throughout the year, obtaining specimens as late as November 10. In the east several specimens of this insect have been reared by Professor Smith in New Jersey, and we have found scales at Riverside, Maryland, and Charlottesville, Virginia, pierced with holes which were probably made by this species. The two other western parasites were reared by Mr. E. M. Ehrhorn in Santa Clara County, California, and are *Aphelinus mytilaspidis* Le B. and *Aspidiotiphagus citrinus* Craw. The other

eastern parasites are *Aspidiotiphagus citrinus* Craw, recently reared from scales from W. E. Hudson, Orlando, Florida, and *Anaphes gracilis* How. which was reared originally from specimens collected at Riverside, Maryland, and later from affected twigs received from Charlottesville, Virginia. It is only fair to suggest that the latter species may not eventnally prove to be a parasite of the San Jose scale, since overlooked specimens of the common oyster-shell bark louse may have been present on the same twigs. The type of this species was obtained in 1880 from *Mytilaspis pomorum*, the common oyster-shell bark louse of the apple.

*Aphelinus fuscipennis* is undoubtedly a very efficient aid in keeping the San Jose scale in check. Mr. Alexander Craw, in the report of the State Board of Horticulture of California for 1891, states that he found it doing such effective work in an orchard in the neighborhood of Los Angeles that complete extermination of the scale was confidently looked for. It was afterwards learned, however, that the orchard became reinfested and also that the partial extermination of the scale in this instance was in a measure seemingly due to a fungous disease.

Fig. 7—*Aphelinus diaspidis* How.

Mr. Koebele refers to the fact that in the case of infested trees on the island of Kauai the scales were nearly all punctured by a minute parasite which he thought might be this species.

### PREDACEOUS INSECT ENEMIES.

Of predaceous insects, perhaps the most interesting is the little coccinellid *Pentilia misella*, which in both the larval and beetle state was found by Mr. Schwarz in great numbers in Charlottesville feeding upon the scale, and which also occurs in other eastern localities. The present season we found its larvæ on twigs from Chestertown, Maryland, collected late in November. The beetles seem to prefer the full-grown female scales, and were frequently observed astride a scale, almost on end, pushing their

heads under the margin of the protecting scale to get at the soft yellow insect beneath. The larvæ of the beetles seem to feed more abundantly on the young scales. Their mode of attacking the older scales was not observed. No eggs of this very useful coccinellid were found, but a favored place of pupation was discovered to be within the calyx of the pears. This cavity is often literally filled with a mixture of young and old scale insects, and frequently contained full-grown Pentilia larvæ, their pupæ, and also freshly issued beetles. (See Fig. 8).

The fact that this beetle, which is essentially an eastern species, so readily and effectively took hold of this introduced scale, is very interesting, entomologically, and, as suggested at the time, would justify an effort to introduce it into southern California. Following up this idea, a considerable number of living and healthy specimens were sent, in May, 1894, to Prof. C. W.

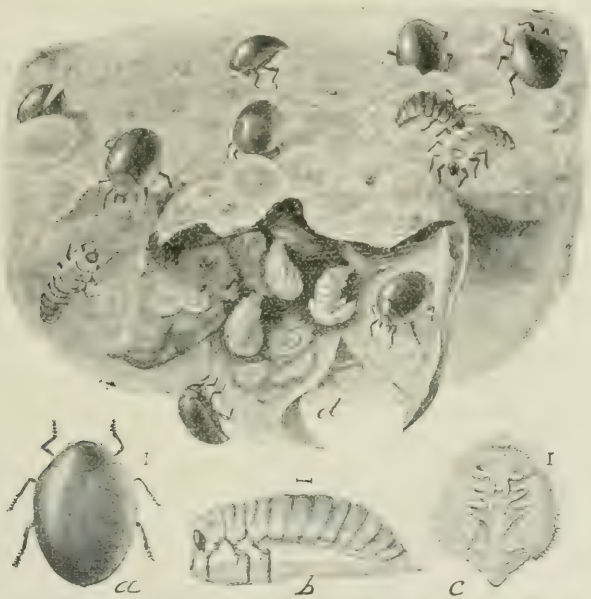



Fig. 8.—*Pentilia (Smilia) misella*: *a*, beetle; *b*, larva; *c*, pupa; *d*, blossom end of pear, showing scales with larvæ and pupæ of Pentilia feeding on them, and pupæ of Pentilia attached within the calyx—all greatly enlarged. (Original.)

Woodworth, at Berkeley, California, who wrote that the insects were received in good condition, and that they had been placed upon a well-infested tree at Oakland, where they could be kept under observation. Since that time, in spite of repeated inquiries, we have been unable to get any information from Professor Woodworth as to the outcome of the experiment.

Our account of this useful beetle coming to the attention of Mr. J. E. McIntyre, of Lespe, California, he urged us to procure for him some living

specimens. Having already sent material to Mr. Woodworth, we were not immediately able to get a supply of the insects for a sending, but at this juncture we received from Mr. G. W. Harney, of Marysville, California, some beetles for determination, which proved to be *Pentilia misella*. He reported that in the mountainous regions of Yuba County many apple trees had been badly infested with *A. perniciosus*, and that hundreds of these little ladybirds were found preying on the scale. The occurrence of this ladybird in California as thus determined, and the fact that it there had the same useful habit, was a most interesting discovery. We immediately had Mr. McIntyre's request transferred to Mr. Harney for attention. It is more than likely that this little beetle is already widely distributed over the Pacific Slope, and it may prove to have a continental distribution instead of being restricted to the east, as originally supposed.

In California the common twice-stabbed ladybird *Chilocorus bivulnerus* is very common and active on trees infested with the San Jose scale, and is an important aid in keeping the scale in check. This species has been reported by Mr. N. W. Motheral, a year or two after having been introduced, to have multiplied in immense numbers and to have effected the extermination of the scale in orchards in Tulare County, California. (Insect Life, Vol. V, p. 53). In the east, however, this ladybird, although common, does not seem to be attracted to the scale.

Various species of the ladybirds introduced, through the agency of Mr. Koebele, from Australia, were colonized on trees infested with *Aspidiotus perniciosus*, and of these *Orcus chalybeus*, *O. Australiasiæ*, and *Scymnus lophanthæ* have since been found preying upon the San Jose scale. (Insect Life, Vol. V, pp. 128, 251; Vol. VI, p. 271). The last-named species was one of the lot introduced by Mr. Koebele on his first Australian trip (1888-89), and was subsequently lost sight of. In 1892 Dr. F. E. Blaisdell described it (*Entomological News*, Vol. III, p. 51) as a new California species of Scymnus, naming it *S. lophanthæ* from the fact of his finding it preying on the San Jose scale which infested the limbs of *Acacia lophantha* near San Diego, California. The interesting facts thus shown are the establishment of the beetle in California and its very useful habit. (Insect Life, Vol. V, p. 127.)

We are informed also by Hon. Elwood Cooper, President of the State Board of Horticulture of California, that of the last importation by Mr. Koebele two species of Rhizobius (*R. ventralis* and *R. debilis*) have been found to feed on various scales in California, including the San Jose scale, but to what extent is not yet known. An undetermined native ladybird, Scymnus sp., has also been observed in California feeding upon the San Jose scale, and there can be no question that most of our common native ladybirds will acquire this habit, and also many of our common predaceous insects, notably the larvæ of lace-winged flies.

Great confidence is being expressed by fruitgrowers in California as to the efficacy of these predaceous insects, and there is a tendency more and more to give up spraying operations and leave the work of the protection of orchards solely to these natural agencies. In explanation of the great benefit experienced in California from natural enemies of scales, Mr. Cooper (letter of December 18, 1894), is of the opinion that this results from the fact

that the climate of California is sufficiently mild to enable many of the predatory species to multiply uninterruptedly the year round. The twice-stabbed ladybird, he says, occurs on plants throughout December and January in great numbers in all stages.

Valuable as these natural enemies undoubtedly are, however, they will be efficient only at intervals, and there will always be considerable periods when, for one cause or another, they will be less numerous, and the scales will then have a chance to multiply. In fact, after the scale has once become established, and the balance between it and its natural enemy has been reached, we may expect with more or less regularity periods of abundance and scarcity of the scale insect. The possible usefulness of parasitic and predaceous insects should, therefore, at least in the east, not be allowed for a moment to interfere with active operations with remedies nor blind one to the importance of the San Jose scale and the extraordinary precautions which should always be taken to prevent its wider dissemination. We have, nevertheless, as an experiment, arranged to introduce certain of the Australian ladybirds into affected Maryland orchards the coming spring.*

# THE RED SPIDER.

By Prof. A. B. Cordley.

This mite is probably the well-known "red spider" of the greenhouse, *Tetranychus telarius*. At Corvallis it is even more abundant upon prune trees than is the clover mite, but it does not seem to have attracted such general attention in other parts of the state. To the unaided eye it appears very similar to that mite, and the general appearance of infested trees is the same. The clover mite, however, is rarely found in the adult stage upon the leaves, and the eggs are always deposited upon the branches or trunk, while the "red spider" may be found in all stages upon the leaves—the eggs, the young in all stages and the adults being protected under a delicate web on the undersides of the leaves.

The winter eggs are deposited upon the trunks and branches, as are those of the clover mite, and when abundant give the bark the same "rusty" appearance.

*Remedy*—Spray with sulphur, lime and salt in the fall as soon as the leaves have fallen.

* Since this paragraph was written, we learn that the New Jersey State Board of Agriculture has passed a resolution calling upon the state legislature to appropriate the sum of $1,000 for the purpose of introducing ladybirds from California into affected New Jersey orchards. If the bill should pass, the attempt will be made in the spring of 1896.

For remedies most efficacious in Oregon, see Spray Calender of this report.—Henry E. Dosch.

# THE PEACH-TREE BORER.

( *Sanninoidea exitiosa* Say .)

Order LEPIDOPTERA ; family SESIIDÆ.

By Prof. M. V. SLINGERLAND.

ALMOST every commercial peachgrower realizes that his success oftentimes largely depends upon his ability to prevent the weakening or destruction of the trees by that king of all peach insect pests—the peach-tree borer.

We suppose that but comparatively few of the peach trees, which have been planted east of the Mississippi River during the last quarter of a century, have lived to produce a crop of fruit without suffering more or less from this dreaded borer.

Several years ago Professor Comstock planned an extensive series of experiments with many of the so-called "remedies" for this pest. A peach orchard of nearly four hundred trees was set near the insectary in 1893 for the sole purpose of experimenting against the insect. Portions of this orchard are shown in Figs. 52 and 53. These experiments have cost much in time and labor. but no effort has been spared to render the results reliable and as conclusive as possible.

### ITS NAME.

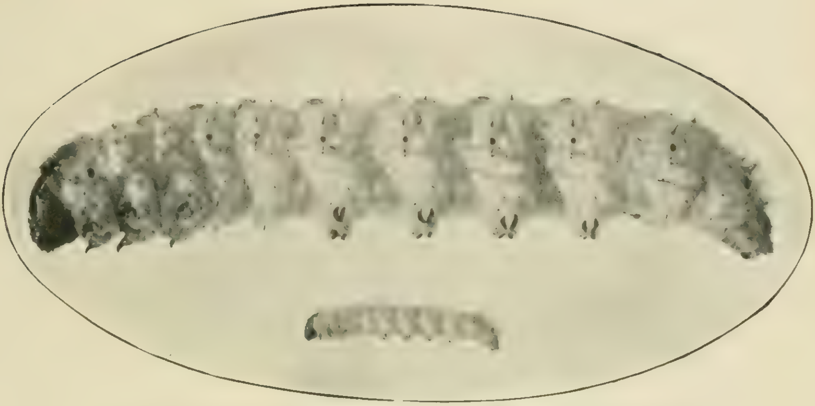
The insect is usually designated by the popular name of "peach-tree borer." It received its scientific name of *exitiosa*, meaning "destructive," in 1823.

### ITS CHARACTERISTICS.

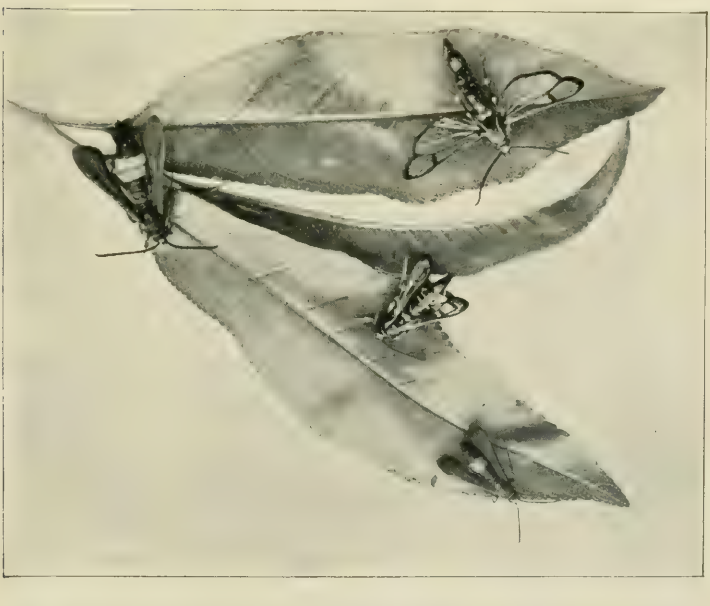
Most peach growers have seen this insect in its destructive or "borer" stage, and doubtless but few ever seen it in any other form. However, the peach-tree borer, like all the butterflies, the moths, the beetles, the flies, and other insects, passes through four different stages ( see Fig. 57 ) during its life. It begins life as an egg, from which hatches the larva or "borer," which has to pass through a pupa stage, from which the adult or moth form of the insect emerges.

When fully grown the "borer" is a light yellow, worm-like creature, whose general characteristics are well shown in Fig. 42. It measures about an inch in length.

The adult form of the parent of the peach-tree borer is a moth. A glance at Fig. 43 will show how easily one might mistake the moth, especially a male, for a wasp, so striking is the resemblance: the unlikeness of the two sexes is well shown in the figure. The moths are of a deep steel-blue color, with narrow yellow stripes on the male and a broad orange band on the female.



42.—The larva of the peach-tree borer, natural size and enlarged.



43.—Moths of the peach-tree borer, natural size The upper one and the one at the right are females.

### FOOD-PLANTS.

The peach-tree borer is par excellence a peach pest, but may also attack both the wild and cultivated varieties of the cherry, the cultivated varieties of the plums or prunes, nectarines, apricots, flowering almond shrubs, and azaleas. The indications are that its original food-plants may have been both the wild plum and the wild cherry.

### HOW IT SPREADS.

It can be easily transported for long distances on infested trees, and this is doubtless the way in which it usually reaches new localities. It is doubtful if there is a peach nursery today east of the Rocky Mountains that is not more or less infested with the peach-tree borer. It is one of the most serious of the insect pests that are now being sent out by nurserymen.

### APPERANCE OF INFESTED TREES.

One can usually quickly determine if a peach tree is infested with borers. The work of the borer always causes the tree to exude a large amount of a mucilaginous matter which forms a gummy mass around the infested portion, as shown in Fig. 45.

Where the peach-tree borer attacks plum or prune trees, however, there is but a slight, if any, exudation of this gummy substance, hence one can not so readily detect its presence on these trees. It is thus more difficult to find the borers in plum or prune trees, and this makes it harder to combat them in these trees.

### THE STORY OF THE PEACH-TREE BORER'S LIFE.

But few peach growers stop to marvel over the wonderful transformations exhibited by this insect in passing through the four stages—the egg, the "borer" or larva, the pupa, and the adult moth—of its life-cycle. And yet, our more successful fruitgrowers are fast realizing that they must know more, and, in fact, can not know too much, about the lives and habits of their insect foes in order to fight them the most successfully.

In New York the moths (Fig. 43) begin to appear in the latter part of June and continue to emerge until September. A few hours after emerging the females lay their small, oval, brown eggs (Fig. 50) on the bark of the trunks of the trees from six to eighteen inches from the ground. From these eggs there hatches, in a week or ten days, a minute larva—the young borer—which at once works its way into a crevice of the bark, and soon begins feeding on the inner layers of the bark. It continues to feed in this manner, gradually enlarging its burrow under the bark, until winter sets in, when it stops feeding and hibernates during the winter, either in its burrow or in a thin hibernaculum made over itself on the bark near the surface of the soil. The winter is always spent as a larva or borer, a few of them being nearly fullgrown, but most of them being considerably less than one-half grown. In the spring, usually about May 1 in New York, they break their winter's fast and grow rapidly for a month or more, most of them get-

ting their full growth in June. (See Fig. 46). They then leave their burrows and spin about themselves a brown cocoon (Fig. 48) at the base of the tree, usually at the surface of the soil. A few days after its cocoon is made, the borer changes to a pupa (Fig. 49) in which stage it remains for about three weeks, usually in June in New York. From the pupa the moth emerges, thus completing its life-cycle in a year, fully ten months of which are usually spent as a borer in the tree, the remainder or a little more than a month being spent in the egg, pupa and adult stages. About the middle of July all stages of the insect may be found in some orchards. The above brief sketch of the life of the peach-tree borer will apply in general to most localities in the United States north of Washington, D. C. In Canada the moths do not begin to fly until about a month later, while in the South they appear a month or more earlier, so that the dates in the above sketch will not apply to these regions.

### ITS NATURAL ENEMIES.

As the peach-tree borer spends most of its life under the bark beneath the surface of the soil, it is not readily accessible to enemies. But it does not entirely escape, for several insects have discovered a way to include this serious peach pest in every course served to their growing progeny. At least eight different enemies of the peach-tree borer have been found, and all of them are parasitic Hymenoptera.

There are indications that in some localities the enemies of the peach-tree borer may play quite an important part in checking the normal increase of the pest.

### SOME GENERAL CONCLUSIONS REGARDING METHODS OF FIGHTING THE PEACH-TREE BORER.

Although American peach growers have been fighting the peach-tree borer for a hundred and fifty years, the results from to-day's methods of warfare are not strikingly different from those recorded by Peters in 1806. Most of the applications now recommended were devised nearly a century ago.

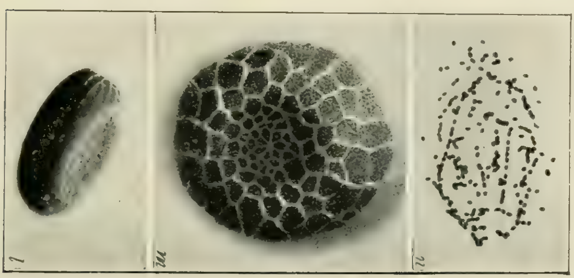
*Cultural methods*—Different cultural methods such as budding on various stocks, irrigation, and cultivation seem to have little or no effect upon the number of the borers. But to make a success of peachgrowing it is usually necessary to thoroughly cultivate and feed the trees, and we believe the borers can be controlled more successfully and much easier in such an orchard.

*Our experiments*—During the past five years we have conducted the most extensive and scientific series of experiments ever attempted. An experimental orchard of four hundred peach trees was set for the sole purpose of testing the so-called "remedies." Portions of this orchard are shown in Fig. 52 and 53. The details of the plan and extent of these experiments are discussed in the unabridged edition of this bulletin. We thoroughly tested about twenty-five representative methods for combating the peach-tree borer.

*Vulnerable stage of the insect*—The insect is open to successful attack only in its larva or borer stage and in its pupa stage; the pupæ are reached only by searching for the cocoons and destroying them.

45.—Base of an infested peach tree, showing the gummy mass surrounding the tree.

46.—Work of a single borer in a peach tree, natural size; w b, burrow of borer; g, gummy mass; p, pupa projecting from cocoon.



50.—Eggs of peach tree borer, natural size, at n; one egg enlarged at l; microphyle end of egg, greatly enlarged at m.


47.—Larva of the peach tree borer, natural size.


48.—Cocoons of the peach tree borer, natural size.

49.—Pupæ of the peach tree borer; natural size at *n*; *m*, male pupa, enlarged: *f*, female pupa, enlarged.

53.—View of the experimental orchard in May, 1897, looking south.

52. View in the experimental orchard in May, 1897, looking east down the rows. Note the different applications on the basis of the trees.

DESTRUCTIVE MEASURES.

Of the destructive or killing methods recommended, the "freezing" method and the use of carbon bisulphide are unsuccessful and unsafe. Boiling water and similar methods have been successfully employed, but they are impracticable on a large scale and may injure or kill the tree.

"*Digging out*" *method*—The "digging out" method is the only thoroughly successful and safe way of killing the peach-tree borer. This method is expensive in time and labor, but our experience leads us to believe that any other equally as successful method will cost just as much. To make it a success, the "digging out" should be thoroughly done, not only on every tree in the orchard, but also on all "old relics" of peach trees in the immediate neighborhood. A half-dozen such "old relics" left untreated near by served to thoroughly restock our orchard with borers every year, so that our "digging out" method, although practiced thoroughly each year, never reduced the numbers of the borers below the danger limit. This is a very important factor in the success of the "digging out" method. Under certain millennial conditions, we believe the numbers of borers could be reduced to the minimum in an orchard by this method alone. Practically every peach grower, who makes any pretensions of fighting the borers, digs them out at least once a year. Many then apply some wash or other device, but curiously enough, they usually attribute any success they may seem to have, not to the "digging out" process, where most of the credit usually belongs, but to the other preventive applications. As our experiments show, however, the application of certain preventive measures after the borers have been dug out, is not a waste of energy where several "old relics" are left untreated near by, or if a neighbor's peach orchard a few rods away is neglected. As these conditions usually prevail in the neighborhood of most peach orchards, we doubt if the "digging out" or any other method used alone, with a few possible exceptions, can be depended upon to reduce the number of borers to the minimum. But we believe there are several combinations of this destructive method with a preventive application which will give better results than either one alone in most orchards, and will keep the pest under control. Dig out the borers in June or in June and September in northern peach-growing districts.

PREVENTIVE MEASURES.

*Plants*—There is little evidence to show that the odor of any plant, like red cedar or tansy, will have any influence on the numbers of the borers when such a plant is set with the tree; such plants would not be desirable adjuncts to peach growing for other reasons.

*Tobacco*—It has been recommended to pile or scatter various substances around the base of the tree to keep out the borers, but only two of these deserve serious consideration.

Nearly a century ago good results were reported from the use of tobacco wound around the base of the peach trees. We tested tobacco stems (midribs of the leaves) from a cigar factory, and the results astonished us. Evidently the tobacco kept out from two-thirds to five sixths of the borers. We are

not sure how the stems acted on the insect, but our results indicate that, where tobacco stems are cheaply obtainable, they will prove a good preventive from the attacks of the peach-tree borer.

*Mounding*—By this old and much-discussed method we apparently kept out from one-half to seven-tenths of the borers. We do not understand just how the mounds of soil keep out the borers, and we doubt if it would give as good results if not practiced in connection with the "digging out" method. The mounding method evidently has considerable value as a preventive and is perhaps the cheapest method yet devised. It is the most practicable method yet suggested for combating the insect in nurseries.

*Paper protectors*—In the early days, cloth and similar protectors were used, but all were soon superceded by the less expensive and equally as effective paper bandages. We kept out from one-half to seven-eighths of the borers with the tarred paper protector shown in Fig. 54. And doubtless, where rains and winds are not too prevalent to interfere with an ordinary newspaper protector, it would give equally as good results as the tarred paper; some report injury to the trees by the use of tarred paper, but our trees suffered no injury from its use. Paper protectors, when carefully put on and kept intact during the danger period, will prove a valuable and very cheap preventive measure, especially when combined with the "digging out" method.

*Wire-cages*—Wooden boxes or tiles placed around the trees are too expensive, and the evidence shows that they afford little protection. The device shown in Fig. 55, however, is strongly recommended by most recent writers, and, theoretically, it is an ideal protection from the ravages of this pest. We confidently believed that we had solved the problem of how to keep out the borer when we placed these wire mosquito-netting cages around some of our trees. But it was a case of misplaced confidence, for our theory was completely demolished when we examined the caged trees next year. The cages apparently proved an attraction to the insect, for nearly twice as many borers got into the caged trees as into those untreated.

*Washes*—The favorite method of preventing the ravages of the peach-tree borer has been, for at least a century, by the use of a wash of some kind. More than fifty different washes have been concocted, most of which are valueless as preventives, and some of which will injure or kill the trees. We tested eighteen washes.

An asafœtida and aloes wash was not offensive enough.

Tallow should have given good results, theoretically, but it proved wholly useless; this was a great surprise to us.

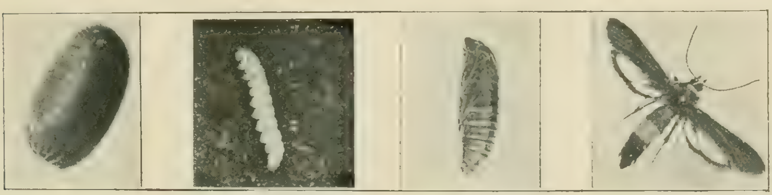
Ordinary soap, or whale-oil soap, even two applications, offered little or no protection. The addition of paris green to a soap wash will not increase its effectiveness, and it may injure the trees. Carbolic acid soaps, or the Shaker wash would afford no more protection than ordinary soaps, we think.

Whitewash, or whitewash and linseed-oil washes were wholly ineffectual in our experiments. We doubt if whitewash and glue, or bordeaux mixture have better preventive qualities.

By making two applications the same season of Hale's celebrated wash,

54.—Peach tree treated with tarred paper in the experimental orchard.

55.—Wire cage protector in position on a peach tree in the experimental orchard. Theoretically a perfect protector, but practically a a useless devise.



57.—The four stages—egg, larva or "borer," pupa, and adult or moth—of the peach tree borer's life; all natural size except the egg, which is much enlarged.

we succeeded in keeping out from one-third to one-half of the borers. This wash will not remain intact long enough in New York State, hence is is of little value unless applied twice, which makes it too expensive a process. We cannot see how Stedman's or other variations of Hale's wash could afford any greater protection from the borers.

Two applications the same season of a lime, salt and sulphur wash and a resin wash gave little encouraging results to peach growers.

A paris green and glue wash killed our trees in a few weeks.

White paint proves to be quite an effective wash, keeping out from one-half to five-sixth of the borers, but it may injure young trees, and we doubt its proving as effectual on old trees.

White paint and paris green, or green paint, is quite an effectual wash, but it seriously injured our young trees, and is therefore not to be generally recommended.

The hydraulic cement wash, which has recently attracted considerable attention, makes an ideal coating over the bark, but we did not succeed in keeping out any borers with it, thus shattering another theoretical idea.

Printer's ink, although it apparently kept out nearly one-half the borers, injured our trees, and thus can not be recommended.

Raupenleim and dendrolene kept out all of the borers, but killed all the trees.

Pine tar kept but a few borers out of our trees.

Gas tar proved to be the best application we tested. We used it freely on the same trees for three successive years without the slightest injury to the trees, and it kept out nearly all the borers. We had been led to believe that tar was very injurious to young trees, and confidently expected to see our trees die each year after being treated with it. But the trees kept just as healthy and grew as thriftily as any others in the orchard. Let the trees become thoroughly established and get a year's growth, and it is our experience that tar can be used with safety on them. Go slow with them, by first testing it on a few trees in your orchard. We believe it will prove equally effective whether the borers are dug out or not, and from no other application yet devised would we expect to get such results when used independent of the "digging out" method.

There are a few miscellaneous washes of very doubtful value.

*Some general conclusions regarding washes*—Lime and some kinds of soap are often the principal ingredients of washes. Our experience leads us to believe that neither of these substances exercise any preventive effect on the peach-tree borer. Furthermore, climatic conditions in New York and doubtless in most northern peach districts, will cause any wash containing much lime to scale off and thus render it ineffective before the moths have stopped laying eggs. Thus soap and lime or clay are useless ingredients, and lime may seriously interfere with the effectiveness of a wash in moist climates.

We do not believe a poison like paris green adds anything to the effectiveness of a wash, and it may prove a dangerous ingredient, as with glue or white paint. The theory upon which the poison is supposed to work is a wrong one. The newly-hatched borer does not deliberately eat its way

25

through the wash and thus get some of the poison, according to the theory, but it seeks a minute crack or crevice and works its way in below the surface bark, on which the wash is applied, before it begins to eat. We believe this last fact, regarding the entrance of the newly-hatched borer into the tree, will explain much of the ineffectiveness of washes. It is very difficult to so thoroughly cover the bark of even a young peach tree that many minute cracks will not be left or soon be made through the wash by climatic conditions or by the growth of the tree.

Crude carbolic acid is another favorite ingredient in washes. Hale says it is the "meat" of his wash, on the theory that its odor is offensive to the moths. In our experience in combating the peach-tree borer or any other insect, we have seen little or no evidence that substances having offensive odors had any repellant effect in keeping the insect away from the food-plant of its progeny. Asafœtida did not in our experience, and we do not believe that any of the effectiveness of tarred paper protectors was due to their odor, for others get just as good results from newspapers; they form a mechanical and not an odorous barrier to the insect. Hence, we do not believe that carbolic acid is a useful ingredient of washes.

Most, perhaps all, of the washes, act simply as a preventive, mechanical coating over the bark to keep the newly-hatched borers out. Such substances as raupenleim, dendrolene, and gas tar seem to be ideal washes, but the first two usually kill young trees, and the last also has a similar reputation in some localities, although we saw no evidence to indicate that tar was injurious to well-established young peach trees. Perhaps someone can so modify these ideal washes as to retain their effectiveness as a preventive and yet eliminate their plant-injuring qualities. Future compounders of washes should work along this line.

We think that most of the above generalizations regarding washes may also apply to washes designed to prevent the work of the apple-tree borer.

*When to apply washes or other preventive measures*—In New York the applications should be made between June 15 and July 1, and they should remain in perfect working order until October 1. In Canada, July 15 will usually be soon enough to make applications, and they should last until November. In the south the applications should be made in April, and they will apparently have to last for three or more months.

*Final conclusions*—In our four years of warfare against the peach-tree borer we have been thoroughly convinced that it is a very difficult insect enemy to control. No method of fighting it has yet been devised by which the peach grower can hope to get a single year's respite; the trees must be treated anew each year and thus the warfare is a perpetual one.

The following substances injured or killed our trees, and are therefore classed as dangerous: Paris green and glue, raupenleim, dendrolene, white paint, white paint and paris green, printer's ink.

The following is a list of things we found to be practically ineffectual or useless: Wire cages, carbon bisulphide, asafœtida and aloes, lime, salt and sulphur; resin wash, hard soap, tallow, tansy, whale-oil soap, whitewash, lime and linseed oil, hydraulic cement wash, pine tar, Hale's wash (one application.)

The following methods proved to be quite effective, that is most of them kept out over one-half of the borers: Hale's wash (two applications) kept out one-third to one-half, mounding kept out one-half to seven-tenths, tarred paper kept out one-half to seven-eighths, tobacco stems kept out two-thirds to five-sixths.

We would expect equally as good results from the "digging out" method applied under the conditions stated on page 383.

Gas tar gave us the best results of anything we tried.

We doubt if the applications listed as quite effective would prove as effective if used alone, hence we would recommend that they be combined with the "digging out" method, for the reasons mention on page 383. Make whichever combination best suits your conditions.

If you find, after a preliminary test on a few trees, that you can use gas tar without injuring your trees, we believe it will prove to be the most effective and cheapest method of fighting the peach-tree borer; but use it carefully and intelligently, as trees have been injured by its use.

We began this investigation confident that some sure preventive of the entrance of the borers into the trees would be found. There was nothing lacking on our part to have the substances we tested do all that they were recommended or expected to do. We did not accomplish our ideal, but we have demonstrated that nine-tenths of the methods recommended are useless. Our experiments furnish much definite data for future workers, and form a definite basis on which to make suggestions regarding methods of fighting the apple-tree borer and other borers. Our experiments must lead to a much more rational and intelligent warfare against the peach-tree borer. Peach growers will now know what not to do, which is often equally as valuable and important as to know what to do. Finally, our experiments have enabled us to point out with confidence certain methods by which the peach grower may hope to control his worst insect enemy — the peach-tree borer.

# NO. 6. THE BUD MOTH.

(*Tmetocera ocellana* Schrif.)

By Prof. A. B. Cordley.

I am not aware that this destructive insect has before been recorded as present in this state, although it has been present in the eastern states for more than half a century and has come to be recognized as one of the most destructive of orchard pests as well as one of the very hardest insects to combat.

### PRESENT AT PORTLAND.

April 21 of this year, I received from Mr. J. J. Borg, of Portland, a quantity of cherry leaves that were being seriously injured by numerous small,

dark-colored Tortricid larvæ. I at once suspected that these larvæ represented the skirmish line of the bud moth, but to be certain I sent a few of them to Doctor Howard, who under date of May 7 replied that "there is little doubt that the larvæ which you send are the larvæ of the eye-spotted bud moth, *Tmetocera ocellana*." May 24 all doubt as to the true nature of the pest was removed by the issuing of several moths of this species.

### DISTRIBUTION.

This insect is of European origin and was first described more than a century ago. In this country it first attracted attention as an injurious species about 1840, the first account of its work apparently being the one published by Doctor Harris in 1841. Since then it has spread over the New England states, the middle states, and Canada, and has been reported from Washington, D. C., Michigan, and Missouri. In 1893 it was introduced at Genesee, Idaho, on nursery stock from Rochester, New York,* and now it has obtained a foothold in Oregon. Whether the Portland specimens have spread from the Idaho importation or whether they have been introduced from the east on infested nursery stock, I do not know.

### NATURE OF THE INJURY.

The small, brown, half-grown larvæ of this insect pass the winter in minute inconspicuous cocoons on the twigs and branches of infested trees. Early in spring, as soon as the buds begin to open, they leave their temporary winter quarters and attacking both fruit and leaf buds, injure many of them so seriously as to stop their growth. On large, thrifty trees this injury is of but little account unless the insects are very numerous; but in young orchards or in the nursery it seriously interferes with the proper shaping of the trees. Some of the larvæ bore into the buds before they have opened, but the larger proportion attack the half-opened buds and feed upon the expanding leaves and flowers, tying them together with silken threads. (See Fig. 2, Plate VI). Some of the partly eaten leaves turn brown, and thus render the work of the insect quite conspicuous. The tying together of the opening leaves and flowers and the brown appearance of many of them, are the most characteristic indications of the work of this pest.

### DESCRIPTION AND LIFE-HISTORY.

The half-grown larvæ winter in inconspicuous temporary cocoons which are usually secreted about the buds on the twigs and smaller branches. (See Fig. 3, Plate VI). When the buds begin to open in the spring the larvae leave their cocoons and attack both leaf and fruit buds as above described. Some of the larvae received from Mr. Borg, April 21, were nearly or quite full grown, while others were scarcely more than one-half grown. They were dark-brown in color with black head and thoracic shield, and were thinly covered with light-colored hairs arising from minute black elevations. The largest ones were nearly one-half inch long.

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* C. V. Piper, Bul. 17, Wash. Expt. Sta., p. 24.



PLATE IV.—The Bud Moth and its work.

Soon after being received they began to spin their silken cocoons within the folded mass of leaves, and on May 12 the first pupa was observed. It is shown at *a*, Fig. 1, Plate VI. May 24 the first moth appeared, and by June 1 apparently all had issued.

During the daytime the moths remain quietly resting upon the trunks and larger branches of the tree, with their wings folded roof-like over the back as shown at *c*, Fig. 1, Plate VI. In this position they so closely resemble the bark in color that it is difficult to detect them. The moths probably live two or three weeks, and beginning a few days after they emerge, fly about from tree to tree, mostly in the night, and deposit their eggs singly or in small clusters upon the leaves. In from seven to ten days these eggs hatch. The young larva, which is at first green, at once begins to feed, usually upon the lower epidermis of the leaf. It soon spins for itself a silken tube open at both ends, and usually located beside the midrib. Fig. 4, Plate VI, shows a leaf that has been partially destroyed. Throughout the summer the larvæ work upon the leaves in this manner, but towards fall they retreat upon the twigs and branches and construct the temporary cocoons in which they pass the winter as before described.

### FOOD PLANTS.

So far I have received only specimens that were attacking cherry leaves. It is, therefore, somewhat early to consider this insect as a prune pest, but in the eastern states it has been known to attack the buds on apple, pear, peach, cherry, quince, and plum trees, and blackberry bushes, and there can be little doubt that, since it is now present in the state, it will soon attack our prunes.

### REMEDIES.

In the east this pest is proving an exceedingly hard one to combat. No satisfactory results have been obtained in destroying the larvæ in their winter quarters, but it is possible that in this climate a winter spraying with strong kerosene emulsion, or lime, salt and sulphur wash, would be effective. It is also possible to destroy a very large proportion of the larvæ by spraying the trees with paris green just before the flowers open. The opening buds should be kept coated with the poison so that the larvæ may be killed before entering within their protecting cover. We are also of the opinion that a thorough under-spraying of the leaves with paris green, between June 1 and June 10, would prove effective. In either case one pound of the poison should be used in two hundred gallons of bordeaux mixture.

Most of our information regarding this insect has been derived from the publications of Mr. Mark Vernon Slingerland, who first worked out its complete life-history.*

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*Bul. 50 and 107, Cornell Univ. Expt. Sta.

# NO. 12. THE PEACH-TWIG MOTH.

(*Anarsia lineatella* (?) Zeller.)

By Prof. A. B. Cordley.

June 9, 1895, Mr. Hugo Garbers, of Hugo, Oregon, reported to this department that the twigs on his peach trees were being destroyed by a small worm boring in at the tip. A few days later, Mr. H. E. Dosch, Horticultural Commissioner for the First District, reported the same injury to prunes as very common throughout his district. Up to and including the eighteenth of June many similar reports were received, some of which were accompanied by injured twigs, each of which contained a single larva.

These larvæ were reddish-pink in color with the head and shield of the first segment pale brown, and corresponded in every particular with Mr. William Saunder's description of the larvæ of *A. lineatella* as quoted by Doctor Lintner in his first report on the "Injurious and Other Insects of New York."

June 22, 1896, some of these larvæ were observed to have left the twigs and to have pupated in various parts of the breeding jars, the pupæ being held in position by a very slight cocoon consisting only of a few silken threads. July 3 four moths issued from these pupæ. These moths agreed perfectly with the description of *A. lineatella* as quoted by Doctor Lintner in the article referred to above.

No further reports of injury to prune trees were received, and nothing more was observed concerning this insect until October 2, 1896, when the strawberry plants on the college grounds, and in a neighboring patch, were found to be very badly infested by reddish-pink larvæ which were not to be distinguished from those that had attacked peach and prune twigs in June. Several infested plants were removed to the insectary, and together with plants out of doors, were examined from time to time throughout the winter, with the result that it was found that the larvæ pass the winter in their burrows in the strawberry crowns in a nearly dormant condition. During the winter infested strawberry crowns were received from several localities, and in every case the burrows were found to contain the larvæ.

May 19, 1897, one moth issued in a cage in the insectary, although an examination of plants out of doors showed that the larvæ were just beginning to pupate, and it was June 1 before any considerable number of pupæ could be found. At the present time, June 15, moths are still continuing to issue. These moths are exceedingly similar to, if not identical with, those reared from peach and prune twigs last July.

From the fact that there was a somewhat extensive attack by the twig-borer last June, and still no evidence throughout the summer, fall, and early winter months, of any attack on prune trees by a second brood of these

larvæ, and since in early fall strawberry plants were so generally attacked by great numbers of apparently identical larvæ, I have been led to infer that the July brood of moths deposits its eggs almost entirely upon the strawberry, although that inference is somewhat opposed to the statement made by Professor Comstock that "the fruit-inhabiting larvæ are found (in peaches) during the latter part of July and August and mature during September,"* and is entirely opposed to the statement of two prominent California authorities, that the small larvæ bore into the bark of infested trees and there pass the winter in the larval stage.†

April 20, larvæ of a twig-borer were received from Halsey, Oregon, and between that time and May 25, when the last specimens were received, the work of this insect was reported from Halsey, Hugo, Lookingglass, Oakland, Dundee, Yoncalla, Junction, Bellefontaine and Granger, and were observed at Corvallis, Liberty and Rosedale. Mr. H. E. Dosch, Horticultural Commissioner for the First District, also writes me that he has numerous letters regarding this pest from various parts, and Mr. C. L. Dailey, Commissioner of the Second District, writes that the "pest is everywhere and small trees are literally denuded of terminal buds."

The first larvæ received were slightly more than one-fourth of an inch long, and were of a dirty brown or dull grayish black color, with head, first and last segments, and true legs shining black. In general appearance they so closely resemble the larvæ of the bud moth that at first I mistook them for that insect. I soon noticed, however, that the habits of the two species were entirely different and that every larva of the twig-borer was readily distinguished by its shining black terminal segment. But this character, together with the general color of the larvæ, rendered them so unlike the larvæ of *Anarsia lineatella* (?) as described, and as seen in strawberry plants, and in prune twigs last June, that it did not occur to me that they could belong to that species, until May 17, when four of the moths issued. One of these moths was at once sent to Dr. C. H. Fernald, who wrote that it is *Anarsia lineatella.*

If this determination is correct, and there can be no reasonable doubt of its accuracy since Doctor Fernald is without doubt the best American authority on the microlepidoptera, we are brought face to face with the peculiar phenomenon of a well-known insect—one which was described in Europe nearly sixty years ago, and which has been an important insect pest in this country for nearly forty years—being bred, in May, from larvæ which are entirely different from those which are supposed to produce it: while on the other hand a very similar but evidently quite distinct insect is bred from apparently normal larvæ of *A. lineatella* which winter in strawberry crowns, and the second brood of which occasionally attacks the twigs of peach, prune, and plum trees in June. Either two species must be involved in this phenomenon or the larvæ of *A. lineatella* must exhibit a double dimorphism due to different food plants and seasons. It appears to us very

*Rept. Com. Agri. 1879, p. 255.
†Alexander Craw, Fourth Biennial Rept. Cal. Bd of Hort.
†C. W. Woodworth, Rept. Cal. Expt. Sta. 1894-95, p. 244.

probable that hitherto two very similar but entirely distinct species have been united under the name *Anarsia lineatella*: that one of these species breeds normally in strawberry plants but may occasionally attack young shoots of the genus prunus in June and July; while the other, so far as known, breeds only upon trees of the same genus, wintering in the half-grown larval condition in shallow burrows in the bark. If this supposition prove true, the interesting question arises, which of the two is *Anarsia lineatella* and what is the other species? May it not after all be the *A. pruinella* Clem, which has been discarded as a synonym of *A. lineatella* Zeller. The proper answers to these questions are of considerable scientific and economic importance since they may have a direct bearing on the efficiency of certain remedial measures.

### DESCRIPTION AND LIFE-HISTORY.

The twig-borer moth is shown at *c* and *d*, Fig. 1, Plate VII, enlarged two diameters. The fore wings are dark-gray, almost black in color, and are splashed with a few short black lines or streaks. The mounted specimens greatly resemble the moths reared from the larvæ in strawberry crowns, but are slightly larger, and darker in color. The habits of the living moths are quite different. Those reared from the strawberry crowns crawl down among the vines even into crevices in the soil, apparently for the purpose of depositing eggs upon the crowns, and when disturbed run or flutter about with wings half spread. On the other hand the moths of the twig-borer invariably take an elevated position in the breeding cage, and with the fore part of the body slightly raised, and the labial palpi held rigidly upright in front of the face, they present a very characteristic and alert appearance. When disturbed they dart rapidly about, suddenly alighting again in the same characteristic attitude upon another portion of the cage. When out of doors upon the trees, it must be nearly impossible to distinguish them from buds. The moths began to appear in our breeding cage May 17, and continued to emerge until June 5.

The larva is shown greatly enlarged at Fig. 2, Plate VII. It is brownish-black or dull, dirty black in color, with head, shield, anal segment, and true legs black, and is covered sparsely with light-colored hairs which arise from minute elevations. When full-grown the larvæ are nearly one-half inch long. They then spin a very loose silken cocoon, wherever they may be feeding, in which they pupate. The first pupa was seen May 8, and since the first moths appeared, May 17, the pupal stage lasts about ten days. The pupa and empty pupal case are shown at *a* and *b*, Fig. 1, Plate VII.

### INJURY DONE.

The half-grown larvæ pass the winter in minute burrows in the bark of infested trees. (See Fig. 3, Plate VII). In spring, soon after the buds begin to open, some of the larvæ leave their winter quarters and bore directly into the center of the buds in such a manner as to destroy the terminal ones. The shoot, therefore, fails to develop, although often the dead terminal leaves may be surrounded by a whorl of well-developed leaves. Later they

attack the rapidly growing shoots, entering them either at the tip or in the axil of a leaf, and boring in the pith as shown in Fig. 5, Plate VII. As soon as the fruit begins to develop, it is also attacked, the larvæ usually boring directly to the pit, upon which they seem to prefer to feed. (See Fig. 4, Plate VII).

OTHER GENERATIONS.

During the summer we shall attempt to determine where the moths deposit their eggs, how many generations of larvæ there are, and how they feed. It is probable, however, that the one or more summer broods of larvæ feed upon the leaves of the prune, and that unless very numerous they do but little injury. As fall approaches, the half-grown larvæ probably retreat upon the branches, where they burrow into the bark and pass the winter, ready to emerge and attack the young shoots as soon as they begin to develop in spring.

REMEDIES.

It is possible that a winter-spraying with strong kerosene emulsion, or lime, salt, and sulphur wash would prove effective in destroying the half-grown larvæ in their winter quarters; but since they must be exceedingly well protected in their burrows, we are strongly of the opinion that the best and cheapest remedy is to spray the trees just when the leaf buds are unfolding with paris green, so that the larva's first meal in the spring will be a poisonous one. The best results will be obtained by applying the poison in bordeaux mixture, using one pound to each two hundred gallons. It is also possible that a more complete knowledge of its life-history will show that this insect may be successfully controlled by spraying at other times.

# BLACK APHIS OF THE PEACH.

(*Aphis persica-niger*, Smith.)

By Prof. Alexander Craw.

The danger of importing eastern nursery stock is not altogether confined to the Yellows or borers, but the black peach aphis is to be dreaded upon the peach as much as the woolly aphis upon the apple. Doctor Smith, who described this insect, says:

"In Deleware, Maryland, and parts of New Jersey and Virginia this aphis was reported everywhere to be unusually prevalent and destructive. In April, when the leaf buds were pushing, I saw them cluster upon so many shoot axes and so compactly as to kill young trees, and even very considerable branches upon older trees. They were especially destructive to nursery trees and to orchards just planted. I saw one nursery in which at least one

hundred thousand trees had been killed outright in two or three weeks' time. I also heard of half a dozen nurseries which were entirely destroyed or very seriously affected, and of orchardists who will be compelled to replant hundreds of trees. Such trees are badly dwarfed, and make only a feeble, sickly growth. The leaves are light green or yellowish, more or less rolled at the margins, and red or purple spotted from the attack of fungi."

It will be seen from the foregoing that this is a very serious pest, and eastern-grown trees should not be planted till properly disinfected; or, to be safe, the practice of planting eastern-grown trees ought to be discontinued.

The description of the species is herewith given, so that it can be identified. The winged form is well represented in the figure, so far as shape and general appearance are concerned. It is of a shining black or very dark-brown color. The legs are deep brown on the thighs, the tips of the shanks, and the tarsi, else yellowish. The cornicles, or honey tubes, are quite long, moderately slender, and of the same color as the body. There is a series of deep pits on each side of the abdomen.

The wingless form differs in the somewhat stouter body, but is very generally like the winged type in color and general structure. The young are of a faint greenish-brown, becoming darker as they grow older, until they are of the typical shining black peculiar to the full-grown specimens. The antennæ of the winged form have the sensory pit extremely developed, every joint beyond the basal knob joints being furnished with them. In the wingless forms the antennæ have only the usual single pit on the third long joint, and the little group on the whip joint.

*Life-history*—This species is found on the roots of the trees throughout the year, and it breeds there quite undisturbed. Early in spring, or when the leaf-shoots begin to start, they make their way to the surface and to the branches. Here the winged form develops, and then makes its way to new quarters, founding new colonies wherever it reaches, and these about midsummer make their way to the ground and to the roots. Usually some few specimens are to be found on the leaves throughout the summer, but they are much more abundant in spring.

No males of this species have been observed, and no eggs have been found.

# PLUM APHIS.

(*Aphis prunifolia*, Fitch.)

This is a species of plant lice attacking the young shoots and unnderside of plum and prune leaves, puncturing them and sucking the sap, thereby checking the growth of the tree and the development of the fruit.

When first hatched they are of a whitish color tinged with green, but as they increase in size they become a deeper green, and when mature some of them are dark, with pale green abdomens and dusky wings; eyes dark brown. The insect and infested leaves are covered with a whitish powder.

This aphis has proved exceedingly destructive in several prune-growing districts. Upon the first appearance of the lice the trees should be immediately sprayed with the rosin wash recommended for young black scale, care being taken to wet the underside of the leaves. Like all other aphis they increase enormously, and a second spraying may be necessary later on.

# THE PEAR SLUG.

(*Eriocampoides limacina* Retzius.)

By Prof. C. L. Marlatt.

## CHARACTERISTICS AND HISTORY.

The damage to the foliage of the pear, cherry, plum, and allied trees from the slimy slug-worm is familiar to every fruitgrower. Two or three generations of these slug-worms, or "slugs," as they are also termed, appear during the summer and frequently in such extraordinary numbers, with the later broods, that the leaves of the attacked plants turn brown, die, and fall to the ground in midsummer, and the new growth of foliage which is afterward thrown out is often similarly destroyed. Trees thus denuded are much checked in growth or greatly injured, if not killed. When the slugs are very abundant, as they frequently are in July during the second brood, the sound of the eating of myriads of mouths resembles somewhat the falling of fine mist or rain on the leaves, and instead of one or two larvæ at work on a leaf there may be upward of thirty. Under such circumstances a very distinct and disagreeable ordor is disseminated by the multitudes of slimy slug-like creatures. The slug-fly is a small, glossy black insect, considerably less in size than the house-fly, measuring only about one-fifth of an inch in length. The wings, which are four in number, are transparent, iridescent, and have a smoky band across the middle, which varies in intensity in different specimens. It belongs to the family commonly termed "saw-flies" (Tenthredinidæ) on account of the saw-like instrument or ovipositor with which the female insect places its eggs in the leaves or other soft parts of the piant.

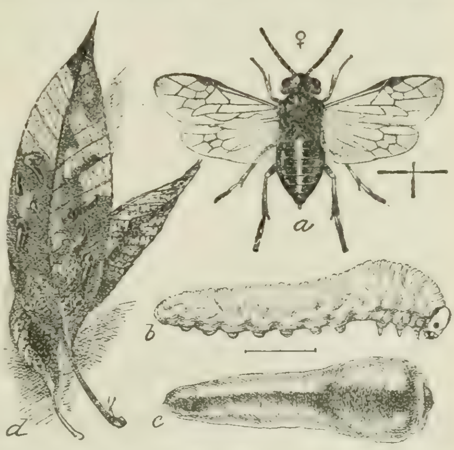


Fig. 1—Pear slug: *a*, adult saw-fly, female; *b*, larva with slime removed; *c*, same in normal state; *d*, leaves with larvæ natural size; *a*, *b*, *c*, much enlarged (original).

The pear slug is an old enemy of fruit trees, and while it has been known in this country for over a hundred years as an American species, the interesting fact that it is the familiar slug-worm pest of the pear and plum trees of Europe has not hitherto been definitely ascertained. In Massachusetts, toward the latter part of the last century, this insect became very destructive, and Prof. Wm. D. Peck prepared an admirable, illustrated account of it under the title of "Natural History of the Slug-Worm," which was printed in Boston in 1799 by the Massachusetts Society for the Promotion of Agriculture. The author obtained for the production the society's premium of $50, and a gold medal. The account of this insect given by Professor Peck is fairly complete and accurate, but for fifty years it has been out of print and inaccessible, and I have not been able to consult it. Harris abridged and condensed it for his account of the slug-worm in his "Insects Injurious to Vegetation," published in 1841, and later writers have generally followed Harris.

In Europe this insect was one of the first of the injurious species that attracted attention, and one of the earliest of the economic writers on insects, Reaumur, in the fifth volume of his bulky work, published in 1740, gives a short account of it, together with recognizable figures of the insect in different stages, illustrating, also, the effect of its work on leaves. The first description and name which stands out unquestioned is by Retzius (1783), who describes the species as *Tenthredo limacina.*

Linne, in describing what seems to have been an entirely distinct insect, which he called *Tenthredo cerasi*, quotes Reaumur's account of the slug-worm, which he erroneously took as belonging to his species, and very generally since, therefore, the former has been called *cerasi* Linn. (Cameron).

Professor Peck, in describing the insect, gave it the name suggested by Linne, and was of the belief that the species occurring about Boston was at most a mere variety of Linne's species, meaning, however, the common pear-slug fly of Europe. Later American writers have treated it as a native species, and under the generic name of Selandria or Eriocampa, Peck has had the credit for it in this country, and the fact that Peck himself associated it with Linne's species has been generally overlooked.

That the species so common in this country is identical with the slug-fly of Europe has been fully established by a comparison of specimens from Europe with abundant American material.

In Europe this insect has been the subject of description by innumerable authors, having received at least nine different specific names and having been referred to some eight genera. In this country it has also been the subject of many short notices, but of very few full accounts other than the one published by Peck.

The pear slug is an insect which is easily distributed with the soil about the plants which it infests, and it has been so carried about the world until it has made its way into practically every civilized country. It is known at least to occur throughout Europe and America and in many of the British colonies. The slugs have been found on a great many different plants, Reaumus recording them on the plum and cherry, and especially pear, but also on the oak, and a recent catalogue by Dalla Torre indicates their occur-

rence on over thirty different plants in Europe. Certain stone fruits and the pear, particularly the latter, are their especial favorites.

LIFE-HISTORY AND HABITS.

The parent fly may be seen on the pear or other trees which serve as food for the larvæ very early in the spring. In Washington, D. C., the present season they were observed on the newly-expanded leaves by the middle of April actively engaged in laying their eggs. In the latitude of Boston and northward the flies do not appear much before the middle of May, and the egg-laying is chiefly during the latter part of May and the first of June. Judging from our experience here many of the eggs laid by the flies which appear in April perish during the cold, wet weather which often characterizes this month. This was the case the present season, few, if any, of the eggs first deposited producing larvæ.

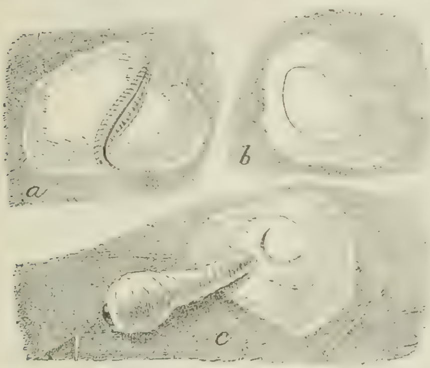



Fig. 2—Pear slug, illustrating method of oviposition and emergence of larva; *a*, cutting of cell beneath epidermis, with ovipositor; *b*, same after egg has been deposited; *c*, same after escape of larva—enlarged (original).

But one egg is doposited in a place, and it is always inserted from the under side of the leaf. The ovipositor is thrust obliquely through the leaf to the upper epidermis, but not piercing the latter, and shows there distinctly through the transparent upper skin of the leaf, as represented in the accompanying illustration (Fig. 2), while the insect otherwise is completely hidden. The saw-like instrument, when brought into the position noted, is moved rapidly with a swinging lateral motion from side to side, cutting the upper epidermis free so as to form an irregular cell or pocket of peculiar flattened ovoid outline. The egg is quickly passed down between the plates of the ovipositor and dropped into the pocket thus made, the time occupied being a little over one minute for the entire operation.

Usually before placing the egg the fly runs about rapidly over the upper surface of the leaf, examining it carefully, and then goes over to the under side to insert an egg, after which she reappears on the upper surface of the leaf and rests for a minute or so before flying to another leaf.

It often happens that a good many eggs are deposited in a single leaf, but I am convinced that this is usually by different flies or at different visits by the same individual. The loosened epidermis about the egg dries somewhat, and the egg-cell soon appears as a minute brownish spot with the almost colorless egg showing at the center. The egg is oval, slightly flattened on one side, and remains in its peculiar cell (see Fig. 2, *b*) for a period of about two weeks before the larva escapes. It is so placed in the

leaf that it can be readily watched and its gradual increase in size by absorption from the leaf and the development of the young larva can be easily studied with a hand lens.

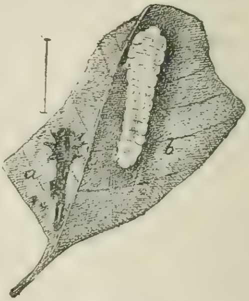



Fig. 3—Pear slug: *a*, last moulted larval skin; *b*, larva after casting last skin—somewhat enlarged (original).

The larva emerges on the upper surface of the leaf through a very regular semicircular cut which it makes near the center of the cell. At first it is clear or free from slime and in color nearly white, except the yellowish brown head; but almost immediately the slimy or gluey olive-colored liquid begins to exude over its entire body, giving it the appearance of a minute slug, or soft snail, from which it gets its name. Its head is dark brown, appearing black under the slime, and the body also becomes almost equally dark. The anterior segments are much swollen, covering up and concealing the head and thoracic legs. In common with other saw-fly larvæ it has a great number of false legs or prolegs on the abdominal segments: in this species there are fourteen such prolegs, the terminal pair being wanting, and the tapering tip of the body is usually slightly elevated.

As soon as the larva emerges from the egg it begins feeding on the upper surface of the leaf, eating out small holes or patches about the size of a pin head or smaller, but never eating entirely through the leaf. The larvæ feed almost invariably on the upper side of the leaves and the minute eaten spots which they make at the start rapidly increase in size until much of it, but not the entire surface of the leaf, is denuded, leaving merely a network of veins, or a leaf skeleton, held together by a nearly intact lower epidermis. Leaves thus eaten turn brown, die, and fall to the ground, the tree being frequently defoliated, except for the effort it usually makes to put out a new growth.

The characteristic features of the larva are its swollen anterior segments and its olive-colored slimy covering, which last is probably a protection furnished by nature against the attacks of parasitic insects. It is very sluggish in movement, but has an enormous appetite. Its growth is rapid, full size being attained within considerably less than a month, usually about twenty-five days, the time varying a little with the nature of the weather. It does not alter much in appearance during growth, and ultimately reaches a length of nearly half an inch. It sheds its skin four times during its larval life, and usually eats its cast skin for its first meal after each moult.

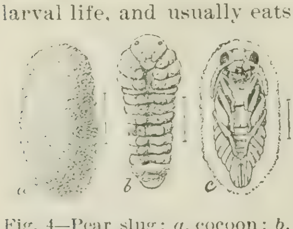



Fig. 4—Pear slug: *a*, cocoon; *b*, contracted larva; *c*, pupa—all enlarged (original).

When full grown it moults a fifth time, but on this occasion leaves its cast skin as a slender line of slime attached to the leaf. The dark olive-green slimy appearance which has hitherto characterized the larva is lost with this last moult (see Fig. 3, *a*, which shows last molted skin), and in its stead it appears as a light orange-yellow worm, perfectly clean and dry, with the head light-colored and only the minute

circular eye-spots black (Fig. 3, *b*). A greenish area shows along the posterior two-thirds of the body, which is merely the remains of the last meal appearing through the transparent skin. The larva does not feed after this moult, but crawls down the plant to the ground, which it burrows into actively, disappearing beneath the surface in a very short time. It penetrates to a depth of from half an inch to two or three inches, usually the lesser distance, and at the extremity of the burrow presses the soil away from itself, so as to form a little cell or chamber, the sides of which it moistens with saliva. The drying and hardening of the walls of the chamber form a sort of cocoon of firm texture and more or less impervious to water (see Fig. 4, *a*).

During the heated season of July and August the transformation from the larval to the pupal stage and from the latter to the adult insect is quite rapid, the pupal stage being assumed in from six to eight days, and the adult flies transforming and digging out through the soil some twelve or fifteen days after the larva entered it.

It seems from the studies by Peck, and in part confirmed by my own observations, that all of the larvæ of the spring brood do not transform at once, but some few of them remain unchanged as contracted dormant larvæ over winter to transform the next spring. It is true also of the second broods of larvæ that some of them come out the same season, while others remain over winter and do not pupate until shortly before the appearance of the adults in April and May. The holding over to the next year of certain larvæ of each brood is doubtless a provision of nature to prevent the extermination of the species by any untoward accident, such as the absence of food, unfavorable climatic conditions, or abundance of natural enemies which might prove disastrous to the species should all appear at once.

In the latitude of Washington, D. C., the first brood of larvæ practically all disappear from the trees by the end of June, and the first flies of the second brood begin to appear about June 20, and are out in greatest number about the first of July. It is the progeny of this second brood of flies that is particularly disastrous to the trees, although the spring brood of larvæ is often sufficiently abundant to do very serious injury.

### NATURAL ENEMIES.

The slimy repellant covering of the larva does not altogether prevent its being preyed upon by parasitic insects, and in Europe some half dozen parasites have been reared from it. In this country Peck mentions a minute parasitic fly, determined by Westwood as a species of Encyrtus, which stings the egg of the slug-fly through the upper epidermis of the leaf, placing in each egg of its host a single one of its own—much more minute. The little parasitic maggot when it hatches finds food enough within the egg of the slug-fly for the needs of its full development, changes to the chrysalis therein, and ultimately emerges a perfect fly like its parent. So abundant is this parasite at times, as reported by Peck, that the second litter of eggs is sometimes nearly all destroyed. I have found evidence of the occurrence at Washington, D. C., of this or some related parasite, but failed to secure the adult insect.

REMEDIES AND PREVENTIVES.

In the effort to exterminate this insect the slimy covering exuded by the larvæ in such copiousness was formerly taken advantage of and applications of various powders and dusts were made to them, such as ashes, lime, or road dust, with the object of having it adhere to their viscid surface and kill them. Under this treatment, however, the larva usually merely sheds the incumbered skin and starts in life afresh with a new coat.

The best means of destroying the slug-worm is to spray the plants with an arsenical wash or with a simple soap solution. The larvæ are delicate and easily killed, and as they eat almost exclusively on the upper surface of the leaf where the poison can be most easily placed, they get the greatest amount of it and are the easiest of all larvæ to be thus exterminated. The plants may be sprayed with paris green or other arsenical wash at the rate of one pound of the poison, mixed with an equal amount of lime, to two hundred and fifty gallons of water.

The soap wash to be effective must be applied at a strength of one-half pound of soap to a gallon of water, first dissolving the soap, preferably whale oil, by boiling in a small quantity of water.

Where one has but a few plants to spray and does not care to employ an arsenical or the soap wash, hellebore may be used either as a dry powder or as a wet spray. The powder may be applied with a bellows or dusted lightly over the plants from a cloth bag, making the application preferably when the plants are wet with dew.

So sensative is the slug-worm, that very heavy rains will often destroy it, and it is much less apt to be injurious in wet seasons. For this reason it may often be possible to rid plants of it by subjecting them to a forcible water spray.

# THE HOP PLANT-LOUSE.

(*Phorodon humuli.*)

By Prof. C. V. Riley.

## LIFE-HISTORY.

Wherever it occurs, whether in England or on the continent of Europe, in New York, Wisconsin, or on the Pacific Coast, the hop plant-louse has substantially the same life-round. The eggs are laid in the fall on different varieties and species of the plum, both wild and cultivated. They are small, glossy, black, ovoid, and are attached to the terminal twigs, especially in the more or less protected crevices around the buds (Fig. 1). From this egg there hatches in the spring, about the time when the plum buds begin to burst, a stout female plant-louse, known as the stem-mother, which differs from the summer individuals by having shorter legs and shorter honey-tubes (Fig. 2). She gives birth, without the intervention of the male, to living young, and this method of propagation continues till the last generation of the season. The second generation grows to full size and gives birth to a third, which becomes winged (Fig. 3), and develops after the hops have made considerable growth in the yards. The winged lice then fly from the plums to the hops, deserting the plum trees entirely and settling upon the leaves of the hops, where they begin giving birth to another generation of wingless individuals.

Fig. 1—Winter eggs of the Hop Plant-louse, and shriveled skin of the sexual female which laid them—enlarged.

These multiply with astonishing rapidity* for from five to twelve generations, carrying us in point of time to the hop-picking season. There then develops a generation of winged

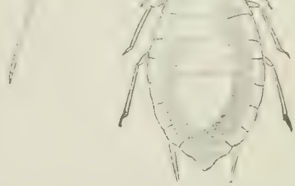


Fig. 2—The Hop Plant-louse, stem-mother, with enlarged antenna above—enlarged.

*Each female is capable of producing on an average about one hundred young, at the rate of three per day under favorable conditions. Each generation begins to breed about the eighth day after birth, so that the issue from a single individual runs up, in the course of a summer, to trillions. The issue from a single stem-mother may thus, under favorable conditions, blight hundreds of acres in the course of two or three months.

females which fly back to the plum tree and give birth to the true sexual females (Fig. 4), which never acquire wings and never leave the plum tree.

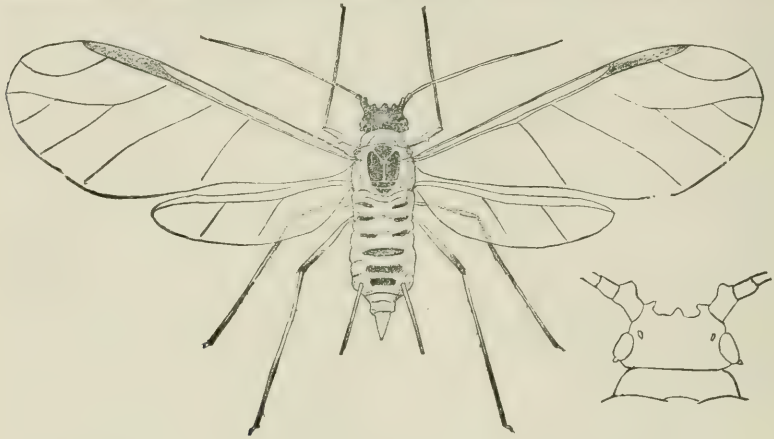


Fig. 3—The Hop Plant-louse, third generation on plum—the generation which flies to the hop—enlarged; head below at right—still more enlarged.

By the time this generation has matured, which involves but a few days, varying according to the temperature, belated winged individuals, which are the true males (Fig. 5), fly in from the hop fields. These fertilize the wingless true females upon the plum leaves and these soon thereafter lay the winter-eggs. Thus there is but one generation of sexed individuals produced and this at the close of the life-round—the females wingless on plum trees; the males winged on hops. All intervening generations are composed of virgin females only (parthenogenetic). This is the invariable round of the insect's life.

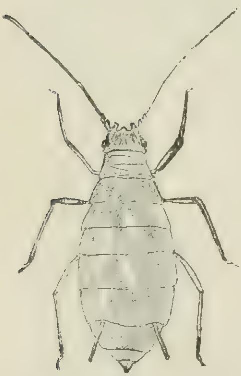


Fig. 4—The Hop Plant-louse, true, sexual female—enlarged.

REMEDIES.

From the life-history just given three important facts are obtained: (1) It will pay to make a preventive application of some one of the mixtures mentioned further on, with apparatus there described, to all plum trees in the neighborhood of hop yards, either (*a*) in the spring before the appearance of the first winged generation and its consequent migration to hop, or (*b*) in the fall after hop-picking and after the lice have once more returned to the plum and are making their preparations for the laying of winter eggs. The latter time will, perhaps, be preferable, for the reason that in the fall the plum trees will be less susceptible to the action of the washes and a stronger solution

can be applied without damage to trees. (2) All wild plum trees in the woods through a hop-growing country should be destroyed. (3) The hop vines should be either burned or thoroughly drenched with kerosene emulsion as soon after the crop is harvested as possible with a view of killing the males, and thus preventing the impregnation of the females. If these measures are carefully followed, comparative exemption from lice may confidently be expected.

Fig. 5—The Hop Plant-louse, male—enlarged.

At the present time it is too late for preventive work, and the only thing which can be done to lessen the damage to the crop is to destroy the lice upon the vines by spraying with an insecticide mixture. Such spraying can, with care, be made quite effective, and the individual hop grower will have the satisfaction of knowing that whatever work he does upon his own yard will not be thwarted by the carelessness of neighbors, as during the summer the lice can not migrate except by crawling from one yard to another.

*Substances to be used.*—Of all the different substances experimented with in 1888 none gave better satisfaction than properly prepared kerosene emulsions and fish-oil soaps.

FORMULA FOR KEROSENE EMULSION.

| | |
|---|---|
| Cheap kerosene | 8 pints |
| Water | 4 pints |
| Soap | 0½ pound |

Dissolve the soap in the water and add (boiling hot) to the kerosene. Churn the mixture by means of a force-pump and spray-nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling, and should adhere without oiliness, to the surface of glass. Dilute one part of the emulsion with twenty-five parts of water.

A common grade of kerosene, which is good enough for this work, can be bought in most localities at eight cents per gallon, by the barrel, and the soap used can be made for one cent a pound. This would make the batch given above çost eight and one-half cents, and diluted with twenty-five gallons of the water to one of the emulsion would make thirty-eight and one-half gallons of wash. At this rate one hundred gallons will cost twenty cents.

FORMULA FOR FISH-OIL SOAP.

| | |
|---|---|
| Hirsch's Crystal Potash Lye | 1 pound |
| Fish-oil | 3 pints |
| Soft water | 2 gallons |

The lye is dissolved in the water, and when brought to the boiling point the oil is added. The batch should be cooked about two hours. When done it should be filled up to make up for the evaporation by boiling, and there will be about twenty-five pounds as a result of the formula. When cold it can be cut and handled in cakes.

The fish-oil will cost about thirty-six cents per gallon in New York City, the lye nine cents per pound. This batch of twenty-five pounds thus costs a little under one cent per pound. A strong suds made at the rate of one pound of this soap to eight gallons of water will be found a uniformly safe and satisfactory wash to use, killing the lice and not harming the vines. After standing three days, however, the suds will lose its efficacy.

P S.—In Oregon the general spray used is Quassia chips.

FORMULA.

| | |
|---|---|
| Quassia chips | 8 pounds |
| Whale-oil soap | 6 pounds |
| Water | 100 gallons |

All boiled together.

The Quassia chips should be fresh, and the whale-oil soap of not less than eighty per cent. strength. Spray as soon as aphis appear and continue as late as practicable.

# APPLE-TREE ANTHRACNOSE.

By Prof. A. B. Cordley.

## SOME PRELIMINARY NOTES.

These few notes are issued to call the attention of growers to a serious disease of apple trees; to indicate the nature of the disease and how it is propagated; and to suggest methods for its control.

The disease is new only in the sense that its cause has never before been described. For several years past the apple orchards of the Pacific Northwest, including Western Oregon, Washington, and British Columbia, have suffered more or less seriously from the attacks of this disease which has been known locally as "canker," "dead spot," or "black spot." In fact the ravages of the disease have been so serious the past season that persons prominent in horticultural affairs have expressed the conviction that the apple-growing industry of the above mentioned regions is threatened with destruction. While not in any sense agreeing with this pessimistic view, we realize that the disease is a serious one, and, several months ago, undertook the problem of discovering its cause, and, if possible, a satisfactory remedy for it. As a result of our work up to the present time the first problem has been solved, and, we believe, we can offer a reasonably satisfactory solution of the second.

## AN UNDESCRIBED DISEASE.

Although of considerable importance, the disease seems to have been almost entirely overlooked, and nothing of importance concerning its nature has been published. Some months ago Mr. Paddock of the New York Experiment Station, at Geneva, discovered that a fungus which causes the well-known "black rot" of apples and quinces, is also the cause of a disease of apple bark which he named "canker." At the time we were in hopes that Mr. Paddock's discoveries would explain the cause of our somewhat similar western disease, but only a cursory examination was needed to show that this is not the case; and recently I have had, with Mr. Paddock, the privilege of comparing the two diseases, with the result that we were both convinced that they are entirely distinct. Further study also convinced me that the disease is a new one and that it is caused by an undescribed species of fungus for which I have proposed the name *Glœsporium malicorticis.*

## COMMON NAME OF THE DISEASE.

As stated above the disease has been known locally as "canker," "dead spot," and "black spot," Ordinarily it is best to accept a common name when once established in a locality, but in this particular instance we believe that confusion in the designation of the disease in future can best be

prevented by adopting for it an entirely new name. The name "canker" is most commonly used in European works on plant diseases to designate injuries to the bark which are caused by various species of *Nectria*. In the Eastern United States it has been applied, by Mr. Paddock, to a disease of apple bark which is caused by a *Sphæropsis*. To apply the same name to a disease which is caused by a fungus entirely different from either of these would only lead to confusion. "Dead spot" and "black spot," the two other names which are sometimes used, applied not only to the disease under consideration but also to diseased areas which are due to various other agencies, such as sun-scald, the pear blight bacillus, etc. In view of these facts and in order to avoid confusion, we shall propose for the disease the somewhat unwieldy name of "Apple-Tree Anthracnose." Although somewhat cumbersome the name seems appropriate from the fact that the fungus which causes it, *Glœsporium malicorticis*, is closely related to numerous other fungi of economic importance which have quite generally been designated as anthracnoses.

### NATURE OF THE INJURY.

Apple-tree anthracnose attacks principally the smaller branches — those under two or three inches in diameter — although it also occurs upon the larger ones and on the trunks of young trees. It appears first in fall, soon after the autumn rains begin, as small, irregular, sometimes slightly depressed, brown areas of the bark. During the fall and winter months it spreads but slowly; but, with the advent of warmer weather in spring, growth takes place rapidly until, under favorable conditions, the disease may invade an area several inches in diameter. Such areas under observation at Corvallis the past season ceased to enlarge late in May, and early in June the first evidence of spore formation was noted. At that time the diseased areas were dark brown in color, markedly depressed, and in most instances limited by ragged, irregular fissures which separated the dead from the surrounding living tissues. These dead spots vary in size from those not more than one-half inch in diameter to extensive areas two or three inches wide by six or eight inches long. Occasionally a single area completely girdles a branch, thus killing at once its distal portion; but more commonly only a dead spot occurs, from which in the course of a few months the bark sloughs off, leaving an ugly wound which requires several years to heal. When these wounds are at all numerous the branches are exceedingly rough and disfigured and are moreover greatly weakened.

### CAUSE OF THE DISEASE.

Apple-tree anthracnose is caused by a fungus which belongs to the genus *Glœsporium*. It is therefore one of the imperfect fungi—so-called simply because the perfect form, if it has one, is not known. If a recently anthracnosed spot be examined carefully, it will be seen to be covered by minute projections. These are known as the acervuli and they contain the spores of the fungus. At Corvallis the past season they began to appear early in June. At first they were noted as small conical elevations of the epidermis.

Reproduction from photograph of characteristic cases of Apple Tree Anthracnose.

which were scattered irregularly over the diseased area. By the end of June these elevations had increased considerably in size and in a few instances the overlying epidermis had been ruptured so as to expose to view the cream-colored mass of spores, which, however, soon became dark-colored. During July, August, and September these acervuli became more and more abundant and by the beginning of October a very large proportion of them had burst open for the purpose of discharging their spores. Spores which were collected late in June were immature and could not be induced to germinate. Others which were gathered in July were also mostly immature, but in October I obtained an abundant supply of mature spores which germinated very readily. The mass of spores in each acervulus can be easily seen with the unaided eye, but the individual spores are so small that they can only be seen by the aid of a good microscope. They average about six by twenty-four microns and are single celled, hyaline or with a greenish tinge, elliptical, curved or geniculate and coarsely granular. Sections through a mature acervulus show, under the microscope, a sub-epidermal stroma from which arise comparatively long, closely compacted basidia, on the ends of which the spores are born. It is the growth of this underlying mass that finally ruptures the epidermis over it and thus sets free the spores.

### HOW THE FUNGUS WORKS.

As stated above, the spores mature, and the acervuli burst open to set them free in late summer and early fall. Thus exposed, the spores are doubtless distributed by the rains and winds and possibly to some extent by birds, insects and other agencies. A vast majority of the spores thus distributed undoubtedly fall in uncongenial places and fail to develop: but occasionally one lodges in a suitable place on the bark of some limb. We found in our work that such spores germinated readily at a temperature of 22° c. (72° F.), but that at a temperature of 29° c. (84° F.) germination was indefinitely delayed. It therefore seems certain that the spores do not germinate during the summer, when the delicate germ tube would be killed by the extreme heat and by lack of moisture; but as we have seen that mature spores are present in immense quantities early in October, and probably considerably earlier, it is fair to assume that they start to germinate soon after the cool fall rains begin. Whether the mycelium of the germinating spores penetrates the cuticle of the apple bark or whether it gains access to the inner tissues through some slight crevice has not been determined as yet. However, after gaining access to the living tissues the mycelium ramifies through them, absorbing the nourishment upon which it grows, and killing the surrounding cells. During the winter, as previously stated, the growth of the fungus and the consequent spread of the disease is slow, but in spring the mycelium takes on a renewed activity, which is shown by the rapid spread of the disease. In May or early in June, the fungus reaches the fruiting stage and from that time all its energies are devoted to the production of spores and the diseased areas cease to spread. Whether the mycelium, having accomplished the object of its existence, the accumulation of nourishment for the production of spores, then dies, or whether it

merely enters a resting stage to be again stimulated to renewed activity by the fall rains, has as yet not been determined, although it has an important bearing upon the means to be employed in controlling the disease as will be shown later.

### THE FUNGUS THE CAUSE OF THE DISEASE.

We have stated above that the disease is caused by the fungus *Glœsporium malicorticis*. It may be of interest to the orchardist to know upon what evidence we base the assertion. It is not necessary to give at this time all details of the work which have led us to the conclusion. In brief, however, spores were induced to grow in artificial cultures. As they germinated they were examined under the microscope, their positions carefully marked, and when they had developed to such an extent that they could be seen by the unaided eye, they were separated from all other growths and transferred to tube cultures. This process was repeated many times and in different ways to eliminate all sources of error. When convinced that no other living organism was present in the tube cultures, a number of sections of apple limb were inoculated with this "pure culture" of the fungus. In about a week after these inoculations were made, slightly discolored areas were observed about several of the points of infection, and in three weeks these areas had developed all the characteristics of the disease as seen in nature: being brown, distinctly depressed and separated from the surrounding living portions by the irregular ragged fissures. Having thus succeeded in producing the disease by inoculating with the fungus, we are justified in asserting that the fungus is the cause of the disease.

### REMEDIES.

Before any experiments in controlling the disease could be intelligently undertaken, it was necessary to know something of its nature. Having shown that it is caused by a certain fungus, the question of most interest is, can it be controlled? And, if so, how? My absence from the state, while studying the fungus itself, necessarily prevented me from conducting any experiments in controlling it, but from what I now know of the disease, I believe that I may safely assert that it can be controlled. We have seen that the spores are developed and probably distributed during the late summer and fall months, and that they undoubtedly germinate after the fall rains begin. It is also known that bordeaux mixture and other copper compounds prevent the germination of the spores of most fungi. We, therefore, infer, that if the trees be properly sprayed with bordeaux mixture, or with the ammonical solution of copper carbonate, once soon after the fall rains begin, and again as soon after the leaves fall as possible, the germination of the spores will be largely prevented and the spread of the disease be thereby checked. It is not expected that such a process will exterminate the disease, but it is believed that it will so reduce its ravages that it can no longer be considered a menace to the apple-growing industry. For the latter of the two applications mentioned above, bordeaux mixture, winter strength, should be used. For the former, bordeaux mixture, summer strength, may also be used, but if the fruit is on the trees it would be better

to use the ammonical solution of copper carbonate. Whichever spray is used should be thoroughly applied, and applied as soon as possible after the fall rains begin. The fungus cannot be destroyed by sprays after is has once entered the tissues of its host.

In addition to the sprayings recommended, we should advise owners of young orchards, or orchards but little diseased, to carefully cut out and paint over with strong bordeaux all anthracnosed spots that may be observed. As stated in a preceding paragraph, it is possible that the mycelium of the fungus in the dead area of bark, after resting through the summer, may be stimulated to renewed activity by the fall rains, and thus itself be an additional means of propagating the disease. Should this be the case, which we are at present inclined to doubt, spraying will not be entirely efficient in preventing the spread of the disease. For the present, at least, or until the above suppositian can be proved or disproved, it will be advisable to supplement the sprayings by using the knife wherever practicable. Old, badly diseased orchards, can best be renovated by pruning severely and spraying thoroughly.

# THE BROWN SPOT OF THE APPLE.

By Profs. L. R. Jones and W. A. Orton.

In the fifth annual report of this station* mention was made of the occurrence of a fruit spot of the Baldwin apple. Examinations at that time revealed an obscure fungus inhabiting the diseased tissues. Specimens were submitted to J. B. Ellis, who reported that the fungus was probably the species called by De Schweinitz *Dothidea pomigena*. Subsequent examinations of herbarium material and literature have shown† that *Dothidea pomigena* Schw. is a quite different fungus from the one which occurred in these spots. We have never secured satisfactory fruiting specimens of the fungus in question, and so far as we know the species remains undetermined. Since it is undoubtedly a saprophyte this becomes a matter of less economic importance.

Re-examination of these brown spots has been made by us on various occasions since our earlier publication. In most cases, especially in the autumn and early winter, no fungus has been detected in the browned tissues, and it has therefore become evident to us that the spotting was not primarily a fungous disease.

*Vt. Sta. Rpt. 5, p. 133 (1891).

†Sturgis in Conn. Sta. Rpt. 21, p. 171 (1897), points out that De Schweinitz's description of *Dothidea pomigena* (*Phyllachora pomigena* (Schw.) Sacc.) agrees very well with the characters of the superficial fungous growth known as the sooty mold of the apple. Unfortunately De Schweinitz left no specimens of this fungus among his exsicatti. A careful comparison of the sooty mold with his description leaves no doubt in our mind as to the correctness of Sturgis' conclusion.

The pressure of other work prevented a more careful study of the matter, however, until the past season. Specimens of Baldwin apples were then examined, beginning with the first evidences of their spotting in the autumn before harvest. The spots in the early stage of their development were found to be covered with an unbroken epidermis and the diseased tissues were free from fungous invasion.

Careful search was also made for bacteria in the browned tissues of the spots and in the adjacent apparently normal tissues. This included both microscopic examinations and the transference with proper precautions of bits of the tissue to various culture media (bouillon, gelatin, agar, and special media containing malic acid).

In no case were bacteria found. There remained no doubt, therefore, in our minds, that the spots were not due to the direct invasion of the tissues by fungi or bacteria.

Several facts of interest were observed, however, some of which had been noted also in previous seasons.

1. While the spotting was worse in case of Baldwins than with any other variety in Vermont, it was not confined to this variety. It was quite common on Northern Spies and was observed also on Greenings.

2. The spots were not uniformly distributed over the surface, but were considerably more numerous toward the eye (apical portion) than toward the cavity of the fruit (basal portion).

3. The spots were not confined to the surface but appeared at various depths in the flesh, the deeper ones often being overlaid by a half inch or more of sound flesh.

4. The spots were associated in their distribution with that of the vascular bundles, occurring at or near the ends of the veins which permeate the flesh of the fruit.

Having opportunity at this stage of the study to confer with the officers of tne Division of Vegetable Physiology and Pathology of the United States Department of Agriculture it was learned that Mr. M. B. Waite and Dr. E. F. Smith had made observations upon a similar spotting of apples which they were satisfied was a non-parasitic disease, and which Doctor Smith considered identical with a dry-spot disease described by Wortmann occurring in Europe.

The examination of Wortmann's paper* leaves no doubt that the disease discussed by him under the name "Stippen" or "Stippich-werden" is identical with the brown spot of the Baldwin, although the Baldwin did not chance to be among the varieties included in his studies.

Wortmann's work has been recently critically reviewed and his conclusions reaffirmed and somewhat extended by Bschokke†. Numerous experiments were devised and conducted by Wortmann and others by Bschokke in connection with their studies which satisfied them of the correctness of their conclusions.

*Wortmann, Ueber die sogenannte, "Stippen" der Aepfel. Landw. Jahrb., 21, pp. 663–675 (1892).

†Bschokke, Landw. Jahrb. d. Schweiz, 11, p. 192 (1897). This author gives a very complete bibliography of the German literature of the disease.

BROWN SPOT OF THE BALDWIN APPLE.

Spotted apple shown in the upper figure. Cross sections through the same fruit in the lower figures. That at the right was made near the apex or eye of the apple, that at the left near the base or cavity. Note the greater development of spots in the former.

[From photographs, natural size.]

As the season was far advanced before we had access to these papers, we have not repeated these experiments. It is of course desirable that this be done with other varieties and especially with the Baldwin. Meanwhile it seems worth while to summarize our present information regarding this spot disease, including Wortmann's and Bschokke's explanation of its causes.

### SUMMARIZED DISCUSSION OF THE BROWN SPOT OF THE APPLE.

*Characters*—This disease usually appears superficially on the fruit as small sunken brown spots scattered over the surface of the apple, but more abundantly near the eye or apical portion. These spots may appear before maturity, but usually are seen only after the apples have lain in storage some time, and tend thereafter to increase in number and size. The spots usually vary in diameter from two to five millimeters (one-twelfth to one-fifth inch). The superficial spots usually lie immediately underneath the epidermis, which in the earlier stage of their development is unbroken. Upon cutting into such a spot it is found to consist of rather dry, dead and browned tissue, extending into the flesh for a distance about equal to its diameter. Similar areas of dead and brown tissue may occur scattered at various depths in the flesh nearly to the core. Most of the above facts are well illustrated in the accompanying figures. Examination shows the spots to be associated in their distribution with the occurrence of the vessels (vascular bundles) of the fruit.

This browned tissue may have a slightly bitter flavor in the older spots, but this bitterness is not constant and in no case in our observation is it very decided.

*Occurrence*—The trouble is of widespread occurrence both in Europe and in America. It is worse on some kinds of apples than on others; and upon the same kind its occurrence varies with climatic or cultural conditions, and probably with those of storage. Wortmann states that large, sappy varieties and specimens are most liable to spot.

The variety pre-eminently subject to it in the northeastern United States is the Baldwin. It has already been stated that it is of frequent occurrence on Northern Spy in Vermont and not rare on Greenings. Selby records the occurrence of the Baldwin spot in Ohio and also that of a brown spot on Northern Spy and other varieties.* Craig† reports it as occurring in the following varieties in Canada: Baldwin, Ben Davis, Fameuse, Golden Reinette, Golden Russet, Hurlbut, Lawver, Malinda, Northern Spy, Orange Winter, Patten Greening, Plumb Cider, Princess Louise, Rawle's Janet, Canada Red, Romna, Salome, Seedling, Seek-no-further, Simbirsk No. 4, Silken Leaf, Talman, Winter Bough, Winter Rose.

Wortmann records the trouble as occuring in varying degrees upon numerous varieties in Europe as follows: Red Reinette, Golderling, Woltman's Reinette, Hawthornden, Winter Pearman, Landsburger Reinette, Stettin, Dantziger.

* Ohio Sta. Bul. 79, p. 134–135, (1897).
† Canada Exp. Farms, Rpt. 10, p. 172, (1896).

*Damage*—The greatest damage is to the appearance of the fruit. The bitter flavor is rarely so prominent as to be serious.

Lamson* who has seen much of the trouble in Baldwins in New Hampshire says that the disfigurement of the fruit is often so great as to render an otherwise perfect apple a second. T. B. Wilson, a large apple grower of Hall's Corner, New York, writes us that these spots "are a great annoyance and cause quite a loss to the orchardists of Western New York." Craig,† speaking of the conditions in Canada in 1896, states that while such apples are not rendered wholly unfit for use their appearance and salability were totally destroyed.

*Cause*—Neither fungi nor bacteri are to be found in the earlier stages of the spot formation nor is there a constant occurrence of any such organism in the latter stages. It is therefore a non-parasitic disease.

Wortmann's observations and experiments lead him to conclude that the death of the cells in these spots is a result of the concentration of the sap following the loss of water. This water may be lost by direct transpiration in the case of the superficial cells, or in case of the deeper cells by excessive conduction of the water to the transpiring surface layers. The acidity of the concentrated sap is considered to be the direct cause of the injury, this injury being followed by the browning through oxydization.

Several factors may therefore enter into the problem of spot formation.

1. The amount of rapidity of transpiration. This is dependent upon the character of the epidermis, conditions of storage, etc. The fact is emphasized that *gradual* loss of sap is essential to the formation of typical spots. Thus a specimen of a variety which is subject to spot will shrivel without the appearance of spots if kept in a warm, dry room. Wortmann suggests that in case of such rapid loss of water the acid of the concentrated sap has insufficient time to act.

2. The kind and relative amount of substances in solution in the cell sap. The same degree of concentration of different solutions may not be equally injurious, hence the actual per cent. of water lost in spotting and nonspotting varieties may not stand in a direct relation to their susceptibility to the disease.

3. The conductivity of the tissues of the fruit. The original loss of water must always occur at the surface. The death of these surface cells may ultimately follow unless this loss is made good by the conduction to them of water from the underlying tissues. In some varieties this conduction occurs more rapidly than in others. Wortmann found that in varieties subject to spot there was relatively slow water conduction.

Bschokke considers this relative rate of water conduction to be the most important factor in deciding the susceptibility of a given variety to the spot disease.

4. The specific resistance of the protoplasm of the cells to the injurious action of the concentrated sap. This is probably greater in some varieties

* N. H. Sta. Bul. 45, p. 46 (1897).
† Canada Exp. Farms Rpt. 10, p. 171 (1896).

than in others, and it may vary also with climatic and other cultural conditions.

*Remedies*—Wortmann concludes that the spotting of susceptible varieties can not be prevented entirely, but that, since trees which are improperly cared for produce fruit of less resistance toward unfavorable influences of every sort, proper attention to fertilization and general cultural conditions is called for. He believes that moist cloudy weather, which decreases starch formation, favors the disease and that in seasons where such weather predominates an excess of nitrogenous fertilizer is especially unfavorable. He recommends a dry sunny exposure and pruning so as to admit sunlight. On theoretical grounds he believes that storage in a moist atmosphere with uniformly low temperature will lessen the development of the spots. He also suggests the probable protection which would come from wrapping the apples separately in paper to check transpiration.

Bschokke revives a suggestion from the older literature that since apples which have lost a considerable moisture from their superficial tissues by rapid evaporation do not spot. Some treatment involving this method might be employed in bad cases. It is doubtful if this will commend itself in actual practice, although it has some theoretical interest.

Lamson finds that spraying Baldwins with bordeaux mixture about as recommended for the scab fungus reduces the amount of spotted fruit to a remarkable degree.

The following is a summary of his results:*

| | *Prevention of brown spot of Baldwin by spraying with bordeaux mixture.* | *Per cent. of spotted fruit.* | |
|---|---|---|---|
| | | *Sprayed.* | *Unsprayed.* |
| 1895 | Sprayed once before and twice after blossoming | 3 | 55 |
| 1896 | Sprayed once before and once after blossoming | 10 | 68 |
| 1896 | Sprayed once after blossoming | 18 | 68 |
| 1898 | Sprayed once before and twice after blossoming | 22 | 52 |

These results are certainly very striking. In view of the above explanations of the cause of this disease the question of why spraying should check the tendency to spot becomes a matter of a considerable practical as well as theoretical interest.

In this connection it should also be observed that Craig reported† adversely to bordeaux mixture as a remedy for this spot, but as his conclusions were based on general observations rather than exact experiments they can not be weighed fairly against Lamson's conclusions.

* N. H. Exp. Sta. Buls. 45 (1897), and 65 (1899).
† Canada Exp. Farms, Rpt. 10, p. 171 (1896).

# PEAR BLIGHT.

By Dr. B. T. Galloway.

In parts of California, Oregon, and Washington where this trouble has shown itself, and, fortunately, they are not many, the following explicit account of pear blight by Dr. B. T. Galloway, Chief of the Division of Vegetable Physiology and Pathology of the Department of Agriculture, will be read with much interest. In pear orchards, where the disease is unknown, it should be always looked for, and the grower will be glad to know what to look for.

*What the blight is* — Pear blight is a contagious bacterial disease of the pear and allied fruit trees. It attacks and rapidly kills the blossoms, young fruits, and new twig growths, runs down in the living bark to the larger limbs and thence to the trunk. While the bacteria themselves rarely kill the leaves, at most only occasionally attacking the stems and midribs of the youngest ones, all the foliage on the blighted branches must, of course, eventually die. The leaves usually succumb in from one to two weeks after the branch on which they grow is killed, but remain attached and are the most striking and prominent feature of the disease.

*How it acts* — The most important parts of the tree killed by the blight are the inner bark and cambium layer of the limbs and trunk. Of course, when the bark of a limb is killed, the whole limb soon dies, but where the limb is simply girdled by the disease, it may send out leaves again the next season and then die. All the parts of the tree below the blight are healthy, no more injury resulting to the unaffected parts of the tree than if the blighted parts had been killed by fire or girdling.

*The cause* — The blight is caused by a very minute microbe of the class Bacteria. This microbe was discovered by Prof. T. J. Burrill in 1879 and is known to science as *Bacillus amylovorus*. The following are the principal proofs that it caused the disease:

1. The microbes are found in immense numbers in freshly blighted twigs.

2. They can be taken from an affected tree and cultivated in pure cultures, and in this way can be kept for months at a time.

3. By inoculating a suitable healthy tree with these cultures the disease is produced.

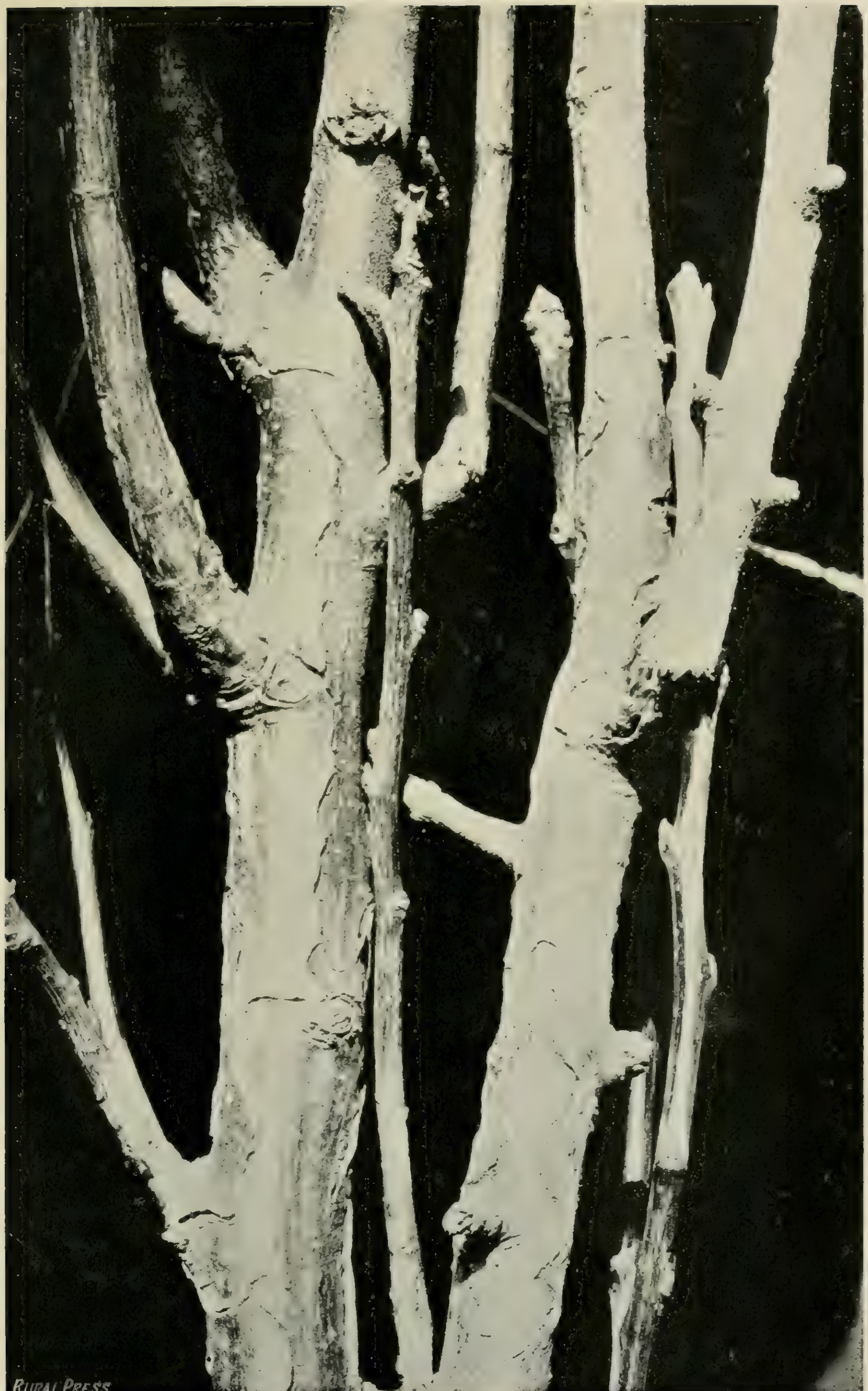
4. In a tree so inoculated the microbes are again found in abundance.

*Treatment* — The treatment of the disease may be classed under two heads:

1. Methods which aim to put the tree in a condition to resist blight or to render it less liable to the disease.

2. Methods for exterminating the microbe itself, which is of first importance, for, if carried out fully, there can be no blight.

The methods under the first head must, unfortunately, be directed more or less to checking the growth of the tree, and, therefore, are undesirable,




CUT SHOWING DISEASED LIMBS OF CRATER BLIGHT.

except in cases where it is thought that the blight will eventually get beyond control of the orchard. Under the head of cultural methods which favor or hinder pear blight, as the case may be, the most important are pruning, fertilizing, cultivation and irrigation; but details in regard to these need not be given here, as the main reliance must be placed in the only really satisfactory method of controlling the disease: that is the extermination of the microbes which cause it. Every particle of blight should be cut out and burned while the trees are dormant, not a single active case being allowed to survive the winter in the orchard or within half a mile or so from it. Every tree of the pome family, including the apple, pear, quince, Siberian crab apple, wild crab apple, the mountain ash, service berry, and all the species of Crataegus, or hawthornes, should be examined for this purpose, the blight being the same in all.

*Cutting out blight.*—The orchardist should not stop short of absolute destruction of every case, for a few overlooked may go a long way toward undoing all his work. Cutting out the blight may be done at any time in the winter or spring up to the period when growth begins. The best time, however, is undoubtedly in the fall, when the foliage is still on the trees, and the contrast between that on the blighted and that on the healthy is so great that it is an easy matter to find all the blight. It is important to cut out blight whenever it is found, even in the growing season. At that time of year, however, it cannot be hoped to make much headway against the disease, as new cases constantly occur which are sufficiently developed to be seen when the cutting is done. In orchards where there are only a few trees and the owner has sufficient time to go over them daily, he will be able to save some which would otherwise be lost. However, when the trees stop forming new wood, the campaign should begin in earnest.

*Examinations for blight.*—Of course, the greater part of the blight can be taken out the first time the trees are gone over. If this should be in midsummer, the trees should be all again carefully inspected in the autumn, just before the leaves shed, so as to get every case that can be seen at that time. After this a careful watch should be kept on the trees, and at least one more careful inspection given in the spring before the blossoms open. It would, doubtless, be well to look the trees over several times during the winter, to be certain that the blight is completely exterminated. In order to do the inspecting thoroughly it is necessary to go from tree to tree down the row, or, in the case of large trees, to walk up one side of the row and down the other, as in simply walking through the orchard it is impossible to be certain that every case of blight has been cut out.

The above line of treatment will be even more efficacious in keeping unaffected orchards free from the blight. A careful inspection of all pomaceous trees should be made two or three times during the summer, and a sharp outlook kept for the first appearance of the blight. It usually takes two or three years for the disease in an orchard to develop into a serious epidemic, but the early removal of the first cases will prevent this and save a great deal of labor later and many valuable trees.

# PEAR SCAB.

(*Fusicladium pirinum* (Lib.) Fckl.)

By Prof. B. M. Duggar.

## GENERAL ACCOUNT.

During the past two years a number of inquiries have been received concerning pear scab, and among the smaller orchardists or others with a small number of trees, equally as many inquiries have related to the well-known pear blight. Consequently, it has seemed well to incorporate in this bulletin such brief accounts of these two diseases as will give the information desired.

The injurious effects of pear scab are well understood by many orchardists; and by some the disease is combated faithfully and successfully, but to others it is an inevitable attendant of pear culture. During the past summer I was surprised to find how often pear scab is confused with certain insect punctures and other minor injuries. I presume, however, that no one who ever grew so susceptible a variety of pear as the Flemish Beauty could long remain ignorant of the scab. Although much is lost when colors are not reproduced, one sees there the essential characteristics of the scab in pronounced form upon the fruit.

With many varieties of pear, this cracking may accompany the scab as as well as the leaf blight, or, apparently even certain irritating external agencies may produce the cracking, provided the respective agencies affect the pear during the growing period.

On the fruit the pear scab produces at first merely brownish or olivaceous markings. These discolorations are due, in part, to a short surface growth of the fungus, and to the deadening of the epidermis of the pear. During the past year Prof. L. H. Bailey received from Michigan some leaves so badly affected that the fungous growth covered the greater portion of both surfaces, and the leaf was considerably curled therefrom.

Pear scab has been known botanically since 1832, when it was found in Belgium; but it is only within the past twenty years that it has had a place in economic literature. Hereafter, at least until unsusceptible and otherwise satisfactory varieties are introduced, to the successful orchardist a knowledge of scab is as essential as a knowledge of pruning.

## SPECIAL CHARACTERS OF THE FUNGUS.

(*a*) *Microscopic appearance*—The olivaceous growth on the fruit, leaves, and twigs is largely made up of short erect threads, somewhat uneven at the tips. These threads produce the spores or reproductive bodies.

(*b*) *How the fungus passes the winter*—It has been seen that pear scab often attacts the twigs of the first year. The fungous threads are extremely

resistant, and buried in the bark of the twigs it is generally admitted that the disease may thus pass the winter, producing the following spring a crop of spores to reinfect the young branches and leaves, as well as the fruit clusters. It is also believed that the fungus may pass the winter in the diseased fruit and leaves. In Germany a winter stage of the fungus has been found belonging to the genus *Venturia.*

In artificial cultures on bean stems and other nutrient media, I have grown for some time the fungi of apple and pear scab. These cultures have yet given no indication of this other fruiting stage, or winter form of the fungus.

(c) *Does pear scab differ from apple scab?*—It is well known that pear scab differs from apple scab in some particulars: but some have claimed that these differences are so small as not to denote that the fungi are distinct. However, it is of considerable practical importance to know that some recent work tends to show that these fungi are distinct species: hence, if this is true, pear scab cannot spread to the apple, and there cause apple scab, or vice versa.

### VARIETIES AFFECTED.

Scab affects to a greater or less extent a number of the varieties commonly grown in New York. The data upon this subject are limited, but it is generally reported that Le Conte, Kieffer, and Bartlett are less attacked than such varieties as Anjou, Lawrence, Duchess, Clairgeau, Sheldon, Seckel, Summer Doyenne, Flemish Beauty, and Jones. On Seckel, Flemish Beauty, and Summer Doyenne, I have found it very abundant during the past two years. In a list of about twenty-four varieties given by Beach in Bulletin 84, of the New York State Experiment Station, we find none other than the three mentioned included among those only slightly attacked.

### REMEDIES.

Since we may assume that this fungus lives over winter in the young branches or diseased fruit, it is quite evident that there is all the more reason for beginning any work of prevention at the earliest time expedient. Fairchild found that before the flower buds open the young scab spots may appear upon them. It is very important to prevent the early establishment of the disease: for once having secured a foothold, spores are rapidly produced, and dissemination is very rapid during seasons favorable for the disease.

For the prevention of this fungus many experiments have been made at various stations with the different fungicides. During the past few years special attention has been given to pear scab at the Geneva Station in New York. The final results are not at all discordant with those of other stations, and recommendations are made somewhat accordingly. Spray three times with bordeaux mixture of the fifty-gallon strength. The first spraying should be made before blossoming, but after the fruit buds burst: the second, immediately after the petals fall, and the third, about two weeks after the second.

# BROWN ROT.

(*Monilia fructigena*, Pers.).

By PROF. A. B. CORDLEY.

## GENERAL CONSIDERATIONS.

In the fall of 1895 a few diseased prunes were received at this station, which were determined by Professor Hedrick and myself to be infested with the fungus of brown rot, *Monilia fructigena*, Pers. Subsequent inquiry developed the fact that in the infested area nearly the entire product of several orchards had been destroyed, and that in all probability the pest had been present in the state for several years.

At the time a prief statement of the presence of the disease was made through the columns of the press and in Press Bulletin No. 5. So far as we have been able to determine these were the first published notices our fruit-growers had received of the presence and nature of this destructive pest, although Doctor Galloway had perhaps intimated its presence, in the statement that it prevails throughout the country and that the losses resulting from its attacks are frequently very great.*

A short article on the subject was prepared by Professor Hedrick for Bulletin No. 45 of this station, and in the fall of 1897 the disease suddenly became so exceedingly destructive over a large portion of Western Oregon, and so many theories were advanced to account for the serious and unusual injury, that I prepared for the *Rural Northwest* a short account of the disease, and of methods to be employed in combating it. This paper, with slight changes, has recently been reprinted in the biennial report of the State Board of Horticulture. Prune growing has become one of the important industries of the state, and since brown rot is one of the most dangerous diseases of the prune, and since none of the above sources of information, except the last, are now available, this bulletin is issued with the hope that it may prove of interest and of value to the prune growers of the state.

Although brown rot has attracted general attention in this state only within the last few years, it is by no means a new and unheard-of pest. Twenty years ago Von Thumen wrote that it is the most widely distributed and perhaps the most noxious of all diseases that occur on fruit. From the more recent writings of European authorities we may infer that the disease is not so destructive on the continent as the above statement would lead us to believe, and it is possible that from this fact we may hope that in the future the disease may lose somewhat of its virulence in this country. Sorauer merely mentions *Monilia fructigena*;† Frank treats of the disease somewhat fully but does not mention its excessive destructiveness;‡ Prillieux describes the disease but states that it is not so serious as in the United States;§ and

*Rept. U. S. Dept. of Agriculture, 1888.
†Pflanzen-Kraukheiten, 1886
‡Krankheiten der Pflanzen, 1896.
§Maladies de Plantes, 1897.

Tubeuf and Smith briefly refer to it as common in Britain and the United States.*

In this country Von Thumen's statement has been abundantly verified. Smith states that this fungus is more common and far more destructive than any other observed on the peach. He estimates that in 1888 fully eight hundred thousand baskets of peaches were destroyed on the Delaware-Chesapeake Peninsula, and that in 1889 the crop was fully five hundred thousand baskets short on account of the blighting of the blossoms by *Monilia*. In Georgia and the far south the loss is sometimes as much as two-thirds of the whole crop. Taft states that in Michigan some seasons a large part of the crop of peaches, cherries and plums is destroyed. Garman has reported serious rotting of apples in Kentucky as due to *Monilia*, and many other instances of destructive attacks could be mentioned.

In this state the disease has attracted attention chiefly on account of the excessive rotting of prunes in the fall of 1897, and of a similar but less serious injury in the fall of 1898. During the latter period, however, we saw badly-infested peaches on sale here at Corvallis and received samples of such fruit from Salem and from Roseburg. Recently Mr. Joe E. Harvey of Roseburg has written me that brown rot has been observed upon peaches in that vicinity during the past four years. At first it attacked the Alexander and other early varieties and did but little damage, but during the past two years it has grown rapidly worse and has spread to other varieties to such an extent as to cause general alarm. Mr. J. R. Casey of Ashland, member of the State Board of Horticulture for the Third Horticultural District, has informed me that the disease is present in Southern Oregon, where, however, it causes but little loss on account of the uniform lack of moisture at the time the fruit is ripening.

### WHAT IS BROWN ROT?

The name which we have selected as the title of this article is not particularly characteristic of the disease under consideration. Many, perhaps most, of the fungi and bacteria which induce decay in fruits are accompanied by a browning of the tissues, and hence might with equal propriety be designated as the "brown rot." The disease to which we particularly refer is variously described as brown rot, ripe rot of plums, fruit rot, plum fruit rot, brown rot of stone fruits, plum rot, peach rot and blight, quince rot, etc., the common name selected depending somewhat upon the fruit or other portion of the plant attacked, but more upon the individual choice of the author. Brown rot characterizes the disease perhaps as well as any of the other names and has the advantage that it is the one by which it is known by our fruitgrowers. Whatever common name may be applied to the disease, and upon whatever fruit or other portion of the plant it may occur, the cause of the disease—the fungus—is the same, *Monilia fructigena*, Pers.

*Diseases of Plants, 1897.

### APPEARANCE OF THE FUNGUS.

Wherever it occurs the presence of this fungus is shown by the production of clusters of ash-grey spores on the surface of the diseased tissues. In passing through almost any of our prune orchards when the green fruit is being picked, or even earlier, one may see here and there a prune that is partly or wholly covered with this ash-grey or blue-grey "mold." Occasionally several such specimens may be seen hanging together in a cluster. If one of these "moldy" prunes be examined it may be observed that the "mold" occurs in clusters which are freqnently arranged in more or less definite, concentric circles, although this arrangement is not so well marked upon the prnnes as upon certain other fruits. By the use of a small hand lens one may determine that each of these clusters consists of immense numbers of minute thread-like projections which have burst through the epidermis. If a little of this "mold" be taken from the fruit and examined with a higher power of the microscope, it may be seen that each of these minute projections is composed of a number of very small oval bodies joined end to end like a string of oval beads.

### THE SPORES.

These minute bead-like bodies are the spores or "seeds" of the fungus, and every infested fruit is capable of producing hundreds of thousands of them. Each spore is exceedingly minute. It is composed of a single cell and is nearly colorless. The shape is generally oval, but both shape and size vary somewhat.

If some of these spores are placed in a perfectly dry place and examined from time to time, it may be noted that they will remain for an indefinite time apparently unchanged. We have examined such spores that had remained for nearly two years without germinating—so long, in fact, that they had lost the power to germinate, as was determined by numerous tests. If other fresh spores are placed in fruit juice, or otherwise supplied with moisture, and kept in a moderately warm atmosphere, it will be observed that in a very short time (two hours or less) each spore will begin to push out a delicate germ-tube. In other words, the spores will "sprout," and if kept under favorable conditions the germ-tubes will grow so rapidly that in from twenty-four to forty-eight hours they will in turn develop spores. We may thus prove that heat and moisture are both essential to the development of the fungus or brown rot.

### THE MYCELIUM.

It is the germ-tube, which by continued growth, becomes the mycelium of the fungus — the vegetative portion — which penetrates the tissue of its host, and under the influence of which the latter assumes the characteristic appearance of brown rot. This mycelium bears the same relation to the whole fungus that the roots, stem, branches, and leaves of a higher plant do to the entire plant. It is the portion which absorbs food materials and assimilates them, and which eventually produces the reproductive bodies or spores.

The spores are produced in immense numbers and are so small and light that they are blown about by the wind, washed about by the rains, and carried about by birds, insects, and other agencies. Should they chance to fall upon the surface of flower, leaf, or fruit, in the presence of moisture and a sufficiently high temperature, the spores will germinate, the germ-tube will penetrate the epidermis and the mycelium will ramify through the underlying tissues absorbing nourishment and inducing those changes which we call brown rot.

Many writers have denied that the germ-tube has the power to penetrate the uninjured epidermal tissues, maintaining that this must be ruptured by other causes. In view, however, of the results of numerous experiments, there can now be little doubt that under favorable conditions the germ-tube has this power. Arthur produced the disease in cherry leaves and blossoms by simply sowing them with spores and keeping them in a moist chamber. Smith has infected the soundest peaches by merely sowing a few *Monilia* spores in a drop of water upon their surface. July 1, 1895, I placed several perfectly sound cherries and plums in a moist chamber and sowed a few spores in drops of water upon their uninjured surfaces. July 3 these spots were slightly discolored, and by July 4 spore clusters had formed on both the cherries and the plums.

While it is evident from the above tests that the germ-tube has the power to penetrate the epidermis of flower, leaf, or fruit when in the presence of sufficient moisture, we have noticed that the disease rarely does attack an uninjured prune until the ripening process is well under way. This is probably due not alone to the resistant epidermis of the green Italian prune, but also to the small amount of moisture in the atmosphere during the summer months. Observations during the past two seasons have shown that in nearly every instance prunes which are infested with *Monilia* early in the season have first been attacked and the epidermis broken by the larvæ of the peach-twig borer, *Anarsia lineatella* Zell. It is these injured prunes which develop the spores with which later in the season the ripening crop is infected. If they were gathered and destroyed from time to time as the rot developed it would undoubtedly aid materially in checking the spread of the disease.

BLIGHTING OF BLOSSOMS.

Upon peaches and cherries the fungus usually makes its first appearance in spring upon the flowers about the time the petals fall. Galloway states that at first a slight discoloration appears at a given point. This rapidly increases in size until at length the entire blossom assumes a brownish hue. After killing the flower the fungus frequently attacks the pedicle, where it produces similar discolorations to those described above. The dead flowers usually remain on the tree for three or four weeks; then, if the weather is wet, they begin falling, and as they consist at this time of a soft mass of rotten tissue, they stick to any part of the tree with which they come in contact. Careful experiments have shown that these rotting flowers are highly infectious and that wherever they touch the leaves or fruit decay sets in. We have never observed this blighting of the blossoms of prunes,

and do not know that it occurs, although it is possible that the excessive blighting in the spring of 1896, which was attributed to the unusual rainfall, may have been due to *Monilia*, which would certainly have flourished under conditions which then prevailed.

### BLIGHTING OF TWIGS.

In the peach, the blossoms of which have very short pedicles, the blight does not stop with the destruction of the flower, but the mycelium of the fungus may extend through the pedicle into the tissues of the twig. The portion of the twig thus attacked soon assumes the charactertistic leathery brown color of brown rot. The extent of the tissue thus involved usually varies with the conditions of heat and moisture, but should it extend around the twig so that the latter is girdled, all of the terminal portion beyond the point of infection will blight. This twig blight of the peach occurs not only in spring when the mycelium enters the twig through the pedicles of the blighted blossoms, but it also occurs in fall, when it enters through the pedicles of rotting peaches, which have been allowed to remain on the trees. This twig blight of the peach, which is due to *Monilia*, should be distinguished from the blight which occurs in spring as a result of the attacks of the larvæ of the peach-twig borer, which is occasionally quite general. Blight of prune twigs is frequently caused by this insect, but I have never observed it to result from an attack of *Monilia*.

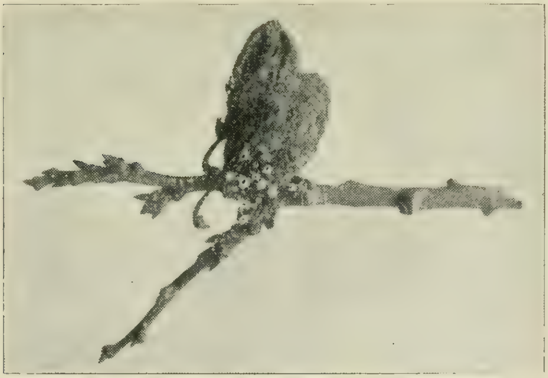
### ROTTING OF THE FRUIT.

The appearance of brown rot upon the fruit varies somewhat with the variety attacked. On cherries and peaches a small circular brown spot appears at the point of infection, and this rapidly spreads until the whole fruit becomes shrunken, soft and discolored. As the disease spreads the surface of the diseased tissues becomes covered with the characteristic ash-gray conidial tufts. In apples, pears, and quinces the disease spreads in much the same way, but more slowly, and usually with less abundant spore formation. In prunes the disease may effect the entire fruit and still produce but little external evidence of its presence. Prunes apparently sound, when opened may exhibit a brownish rotten appearance due to the work of the fungus. We have seen many bushels of prunes taken into the warehouse at night in an apparently healthy condition, which the following morning were well covered with the conidial tufts of *Monilia*, and many of these prunes which did not show such tufts and were placed in the drier under the impression that they were in good condition, failed to produce a good quality of dried fruit. About the first external evidence of brown rot in the Italian prune is the presence of the conidial tufts, and these do not develop freely unless in a warm, moist atmosphere.

### BROWN ROT AND ORCHARD CONDITIONS.

We have hitherto considered brown rot largely from the laboratory standpoint. Let us now examine the same facts in their relations to orchard conditions.

PLATE I. FIG. 1.—"WINTER MUMMIES."



BROWN ROT.

During the dry summer months, although the spores may be and probably are present, the disease does not spread rapidly because the spores do not readily germinate under the conditions which then prevail. But here and there the skin of a prune becomes broken, allowing the spores free access to the moist interior. Thus it is that we have the occasional "moldy" prune to which we have previously referred as being present during the time of green fruit shipments. Through the agency of winds, insects, etc., the almost innumerable spores produced on these early infected fruits are constantly being distributed to other fruits. In the absence of moisture myriads of these spores fail to germinate, and if these conditions unfavorable to germination should prevail throughout the ripening period and while the fruit is being gathered, little or no damage would be done by brown rot.

But it often rains during this period; and even though it does not rain, there are many days when the air is highly charged with moisture. If at the same time the temperature is sufficiently warm the conditions for the germination of the spores are almost perfect and the disease spreads with exceeding rapidity.

### WHERE THE FUNGUS PASSES THE WINTER.

Considerable of the rotting fruit was left in the orchards last fall and may now be seen hanging to the trees and lying upon the ground. Fig. I, Pl. I, shows some of these "winter mummies," which were taken from an orchard in this vicinity late in February. In another orchard we discovered several bushels of rotted fruit which had been culled from that sent to the drier, and instead of being destroyed had been dumped upon the ground in the orchard. Countless millions of spores were present upon this fruit, and there is abundant evidence that such winter spores will retain their vitality until spring. In addition to these spores which were developed in the fall, and which, as stated, retain their vitality until the following spring, the fungus has another method of surviving the winter. Smith has shown that the mycelium which ramifies through and through the tissues of the fruit, disintegrating the cells and causing rot, may remain dormant throughout the winter in the "winter mummies," and with the advent of warm, moist weather in spring, will again push forth an abundant crop of spores. Humphrey and Chester have demonstrated the presence in these "winter mummies" of certain thick walled moniliform threads and single cells which they consider to be resistant resting spores which further insure the survival of the fungus through the winter. Should the weather conditions be favorable for the germination of the spring crop of spores at the time the trees are in bloom, these spores may be the cause of a more or less serious blighting of the blossoms, and even of the young tender shoots of the peach, but whether this occurs or not, the spores will be present to infest the fruit whenever the conditions of heat and moisture do become favorable.

### REMEDIES.

The disease is one of those by which the prune grower is forced "to prove his faith by his works." It spreads so rapidly when the conditions

are favorable that it is nearly useless to attempt its control under such conditions. All methods must be preventive. And yet a grower may almost be excused for hesitating to apply somewhat expensive preventive measures for the purpose of controlling a disease that may not cause any serious loss for several years on account of lack of favorable weather conditions. Now that the disease is well established, however, any prune or peach grower who fails to employ preventive measures, deliberately takes the chance of losing a large proportion of his crop by brown rot, even though such loss may not occur every year. Preventive measures are in the nature of insurance.

Since, so far as is known at present, the fungus passes the winter only in the mummies which remain hanging to the trees or lying upon the ground, the first method of preventing the disease which presents itself is to destroy these mummies. Not a single one should be allowed to remain in the orchard over winter. All should be gathered and completely destroyed. This is the least expensive and perhaps the most important step in preventing brown rot. It should, however, be supplemented by spraying. This station has under way extensive experiments in spraying prunes for brown rot, and it is hoped that by another season sufficient data will have accumulated to enable us to outline definitely the best methods to be pursued in this locality. Chester, of the Delaware station, has conducted the most careful and extensive experiments along this line, and, as a result of three years' work, he recommends that

(1) Very early in the spring it will be well to spray the trees thoroughly with a solution of copper sulphate, one pound to twenty-five gallons of water.

(2) When the fruit buds begin to swell, spray either with the acetate of copper solution or the bordeaux mixture.

(3) Just before the first buds open repeat the latter.

(4) When the bloom begins to shed spray with bordeaux mixture.

(5) In ten days or two weeks repeat the latter.

(6) When fruit begins to color spray with the copper acetate solution.

(7) Repeat the latter in a week or ten days.

This is evidently a larger number of applications than prune growers can afford unless it can be shown that they are all necessary. We believe that except on peaches sprays Nos. 2 and 5 of the above list may be omitted, and that if care be taken to carefully examine each tree just as the fruit is coloring and to remove all infested fruits spraying 6 and 7 may also be omitted unless the weather conditions appear favorable for the rapid spread of the disease. Should the weather become moist and warm, however, the applications of copper acetate should be made immediately.

Bordeaux mixture can be used for all applications but it is liable to discolor the fruit if used for the late applications. For the last sprayings, therefore it is better to use the copper acetate solution, using four ounces copper acetate to forty-five gallons of water. Bordeaux mixture is ordinarily made as follows:

| | |
|---|---|
| Copper sulphate | 6 pounds. |
| Lime (unslacked) | 4-6 pounds. |
| Water | 50 gallons. |

So much depends upon the correct preparation of bordeaux mixture that we quote in full the directions for its preparation which are given by Doctor Galloway of the United States Department of Agriculture:

"It has been found that the method of combining the ingredients has an important bearing on both the chemical composition and physical structure of the mixture. For example, if the copper sulphate is dissolved in a small quantity of water and the lime milk diluted to a limited extent only, there results, when these materials are brought together, a thick mixture, having strikingly different characters from one made by pouring together weak solutions of lime and copper sulphate. It is true, furthermore, that if the copper sulphate solution and lime milk are poured together while the latter or both are warm, different effects are obtained than if both solutions are cool at the moment of mixing.

"Briefly, the best results have been obtained from the use of the bordeaux mixture made in accordance with the following directions: In a barrel or other suitable vessel place twenty-five gallons of water. Weigh out six pounds of copper sulphate, then tie the same in a piece of coarse gunny sack and suspend it just beneath the surface of the water. By tying the bag to a stick laid across the top of the barrel no further attention will be required. In another vessel slack four pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this it is best to place the lime in an ordinary water pail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear add another quart or more, exercising care that the lime at no time gets too dry. Toward the last considerable water will be required, but if added carefully and slowly a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked add sufficient water to the paste to bring the whole up to twenty-five gallons. When the copper sulphate is entirely dissolved and the lime is cool, pour the lime milk and copper sulphate solution slowly together into a barrel holding fifty gallons. The milk of lime should be thoroughly stirred before pouring. The method described insures good mixing, but to complete this work the barrel of liquid should receive final stirring, for at least three minutes, with a broad wooden paddle.

"It is now necessary to determine whether the mixture is perfect—that is, if it will be safe to apply it to tender foliage. To accomplish this, two simple tests may be used. First insert the blade of a penknife in the mixture, allowing it to remain there for at least one minute. If metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as perfect as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more milk of lime should be added.

"The foregoing directions apply to cases where small quantities of the mixture are needed for more or less immediate use. If spraying is to be done upon a large scale, it will be found much more convenient and economical in every way to prepare what are known as stock solutions of both the copper and lime. To prepare a stock solution of copper sulphate, procure a barrel holding fifty gallons. Weigh out one hundred pounds of copper sulphate, and after tying it in a sack suspend it so that it will hang as near the top of the barrel as possible. Fill the barrel with water, and in two or three days the copper will be dissolved.

"Now remove the sack and add enough water to bring the solution again up to the fifty-gallon mark, previously made on the barrel. It will be understood, of course, that this second adding of water is merely to replace the space previously occupied by the sack and the crystals of copper sulphate. Each gallon of the solution thus made will contain two pounds of copper sulphate, and, under all ordinary conditions of temperature, there will be no material recrystallization, so that the stock preparation may be kept indefinitely.

"Stock lime may be prepared in much the same way as the copper sulphate solution. Procure a barrel holding fifty gallons, making a mark to indicate the fifty-gallon point. Weigh out one hundred pounds of fresh lime, place it in the barrel and slack it. When slacked add sufficient water to bring the whole mass up to fifty gallons. Each gallon of this preparation contains, after thorough stirring, two pounds of lime.

"When it is desired to make bordeaux of the fifty-gallon formula it is only necessary to measure out three gallons of the copper solution, and, after thorough stirring, two gallons of the stock lime; dilute each to twenty-five gallons, mix, stir, and test as already described. One test will be sufficient in this case. In other words, it will not be necessary to test each lot of bordeaux mixture made from the stock preparation, provided the first lot is perfect, and no change is made in the quantities of the material used. Special care should be taken to see that the lime milk is stirred thoroughly each time before applying. As a final precaution it will be well to keep both the stock copper sulphate and the stock lime tightly covered."

Acknowledgements are due Dr. W. J. Beal of the Michigan Agricultural College, under whose directions all of our laboratory studies of *Monilia* were conducted.

# NURSERY HINTS.

By L. C. Corbett.

Success in the nursery business follows the man who has untiring energy, coupled with a knowledge of the methods of his art. Growing nursery stock is one of the most intensive divisions of the art of soil culture; we have to deal with small, tender plants, the success of whose growth frequently depends upon a few hours' work just at the proper time.

Viewed from an æsthetic standpoint, the nursery business presents quite a different scene. The materials and factors with which the nurseryman daily comes in contact are themselves sufficient to stimulate him to greater activity, and, at the same time, to develop in him a love for nature and nature's God. The man who sows a seed and rears a plant from it has witnessed a transformation almost miraculous in its nature. But this process is so common that it creates neither wonder nor admiration. Is it strange, then, that the cultivators of the soil act "by rule of thumb" and tradition when they know not what they do or with what mysterious powers they are dealing. It is time that we become lovers of our art rather than mere servants of it. Plants should become entities possessing life and individual characters which are pleasing to us rather than mere machines for transforming so much inorganic soil material and sunlight into fruits or flowers, which, at the close of the season, will make us that much richer. But the conception of the plant world as a great manufacturing establishment is much better than no conception of it at all. Study every factor with which the plant you are growing has to deal. The beauty, harmony and complexity of the cycle of life of any plant will leave you richer for having traced it. After viewing one scene of nature's theater, the student will ever be asking a glimpse of another. The love of witnessing this panorama is what lifts the horticulturist and the agriculturist out of the sphere of the laborer into that of the investigator, and what was before irksome toil now becomes pleasure, because we are prepared to enjoy what it unfolds.

The canvas and unmixed colors without the skilled artist are no more than so much clay. The soil, the plant, and the atmosphere are to most of us merely so much raw material, we use them as we have been taught, without stopping to ask why; but as soon as the plant suggests to us its complex and beautiful round of life, instead of merely what it is good for, then we are led into nature's secrets of "how plants grow and how plants feed."

The following pages, as the title indicates, are intended to stimulate an interest in the art of propagating plants. Aside from the economic features of the work, the growing of plants is itself a fascinating occupation, but there are so many benefits to be gained by the local production of nursery stock, that fruitgrowers of a developing region cannot afford to neglect this art. The introduction of dangerous pests can be avoided, scions and buds from trees thoroughly acclimated can be obtained by the propagator, a

pedigreed tree can, therefore, be produced; and what is equally important, the young stock will not be forced to suffer the shock of long transportation and a change of climate. To those who have studied the question, no stronger argument can be brought in favor of the home production of seeds and trees than effects of climate upon plants.

The home-grown trees may possess these points of advantage: Freedom from foreign pests, such as the San Jose scale; to have been grown from buds or scions of perennial bearing trees; to be thoroughly acclimated; and last, and by no means least, the orchardist can have his trees grown by contract from scions or buds from his favorite trees. He thus has the satisfaction of knowing exactly what he has purchased.

In considering this subject, it has been taken up by topic, in order to give prominence to its various subdivisions. These have been made to conform as closely as possible to the natural order in which they would be considered by the expert nurseryman.

## NATURAL PROPAGATION.

Seedage, i. e., propagation of plants from seeds, is in most departments of our rural art a very easy operation. The nurseryman and florist, on the other hand, frequently encounter, just here, some of their greatest stumbling blocks.

For the successful germination of a seed, three conditions are essential, in fact, all three must be present, in order that the life processes in the seed be started. These are heat, moisture, and free oxygen. If any one of this trio be lacking, as has before been stated, germination will not take place.

With the cereal grains and most garden seeds, these conditions, as they are given us during nature's growing season (springtime), are all that is necessary.

But with hard-shelled and nutty seeds, as well as those having a delicate seed covering and low vitality, the conditions are different.

Seeds with hard shells or integments, like the apple, peach, plum, acorns, etc., must be stratified, if they are to germinate readily at planting time.

Stratification is planting in the fall in its simplest form. Seeds of the character above mentioned are gathered at maturity and then immediately stowed away in boxes containing first a layer of sand, then a layer of seeds, then sand, and so on until the receptacle is filled. It is then placed, in the more southern latitudes, on the north side of a building or hedge, where it will freeze and remain frozen during all the colder portion of the winter. If the propagator is further north, he buries the box a few, or many inches deep, according to the depth of the frost line in that locality.

The intention of this operation is to induce freezing and thawing once or twice during the winter and to overcome repeated freezing and thawing as well as too severe freezing. Bags are sometimes employed instead of boxes as receptacles for seeds to be stratified, but experience has proven that boxes are, under all circumstances, to be preferred. In the case of walnuts or acorns, it is not necessary to take the trouble even to mix them with sand. When such seeds are to be handled in quantity, they may be piled in a broad,

flat heap and slightly covered with forest leaves. It is best to select a sheltered place for such heaps, as in a young growth of timber or at the north of a hedge.

Planting stratified seeds in the spring should be given as careful attention as the process of stratification itself. Large seeds should be screened out and dropped at proper intervals along trenches of suitable depths, and immediately covered with fresh earth. Exposure to sun and wind for a few hours after removing from stratification may cause the loss of what might have been a good stand of trees. Small, fine seeds may be scattered with the sand along the furrow and lightly covered or tramped in.

Fig. I.

Seedlings may be grown in rows, or the seeds may be sown broadcast, but in all cases, except when the plants are to be budded instead of grafted, it is not necessary to sow the seeds in rows having the desired distance of the nursery row between them, as all root-grafted and crown-grafted trees, as well as many budded trees, are transplanted once or twice before being worked. In our own state it is believed that seedlings should always be grown in rows instead of broadcast in seed beds.

*Root stalks*—The nearest approach to the use of root stalks that falls within the work of the nurseryman is the propagation of blackberries from

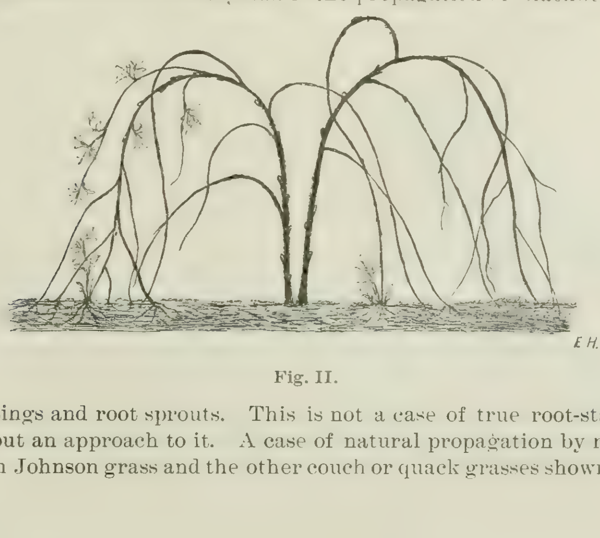



Fig. II.

root cuttings and root sprouts. This is not a case of true root-stalk propagation, but an approach to it. A case of natural propagation by root stalks is seen in Johnson grass and the other couch or quack grasses shown in Fig. I.

*Stolons*—Increasing plants by their ability to avail themselves of new territory by striking root at the end of the branches is of great economic importance to the nurseryman. Black raspberries and strawberries are propagated exclusively by this means. The black-cap strikes root readily at the end of the shoot, as shown in Fig. II, and strawberries (Fig. III) throw out numerous runners, which strike root at intervals along their course and give a large increase per plant.

*Layers*—The distinction between layers and stolons is that in the case of stolons the act of striking root is wholly dependent upon natural conditions,


Fig. III.

while layering is a voluntary operation on the part of man. A layer is a branch placed in contact with the earth for the purpose of inducing the formation of roots, the shoot or branch remaining the meanwhile attached to the parent plant. Layering is a favorite method of multiplying woody plants, which strike root from cutting with difficulty. The quince, currant, gooseberry are easily multiplied by stools, which is a form of layering shown in Fig. IV. The grape is easily increased from layers made by burying a cane at intervals or throughout its whole length ; roots and branches are thrown out at the nodes or joints and each one forming roots may be used as an independent plant by detaching it from the parent. Such a layer is shown at Fig. V. The growth of the young plants resulting from layering would not appear as represented in the drawing, but the largest plant would undoubtedly be the one farthest from the parent, and it might be the only one formed in the entire length of the layer, unless means of checking its growth were used so as to stimulate growth from the other buds.

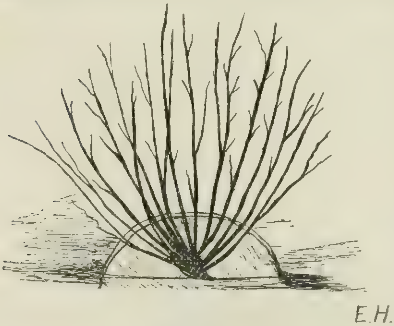



Fig. IV.

*Suckers or root sprouts.* The young shoots that spring up around blackberry, red raspberry, plums, pears, and many of our cultivated plants are good illustrations of this mode of reproduction. In forestry this natural mode of reproduction is a favorite resource for certain lines of work, as the production of tanbark, posts, and stovewood, and is given the special name of the Coppice System of forestry. Nursery practices are greatly facilitated by this natural tendency in plants which reproduce their kind true to variety. This is the case with all the red raspberries, and blackberries. Some plums also reproduce true to name in this manner.

Fig. V.

In general, seedlings, and all plants that have been grown from cuttings will come true from root sprouts, if they reproduce in that way. Outside the bush fruits, however, this method of reproduction should be discouraged rather than encouraged. Nothing is more annoying to the orchardist and fruitgrower than the persistent sprouting of some plants—the hazel and the blackberry are striking examples of such nuisances: also some of the poplars when used as lawn trees.

## ARTIFICIAL REPRODUCTION.

The primary object of the nurseryman's business is to multiply plants, and secondly, to perpetuate cultural varieties. The most of the art then consists in the perpetuation of cultural varieties, for as we have already seen, nature has amply provided for the simple multiplication of plants. The artificial methods which we now have to consider are the chief resources of the nurseryman in the perpetuation of all desirable varieties of fruits. If it were impossible to continue the existence of a variety of apples through seeds, root sprouts, or some one of the natural processes of reproduction, that variety, no matter how desirable it might be, would be lost but for the resource found in the man-made processes of reproduction; and if these processes were taken from the civilized world to-day, the duplication of our large orchards, vineyards, and orange groves, made up as they are of only a few varieties, would be an absolute impossibility. The importance of these processes in modern horticulture is sufficient to justify a somewhat careful description of the simplest and most important of them.

*Cuttage*—The process or operation of propagating plants by cutting is called cuttage.

A cutting is a detached portion of a plant inserted in soil or water with the intention that it shall grow.

In nursery practices, a knowledge of hardwood cutting, herbaceous cutting and root cutting will, in general, prove sufficient.

*Hardwood cutting*—This term is interpreted as applying to cutting made from ripened wood of deciduous plants of the present or previous season's growth.

Plants that are usually propagated in this way are: grape, currant, gooseberry, willow, poplar, cranberry (not deciduous) and some conifers.

From a commercial standpoint this is one of the most important of the artificial methods of propagation, and when the great number of plants of grapes, currants, gooseberries, poplars and willows, all of which are propagated in this way, are taken into consideration, the pecuniary value of this method becomes evident. By no means the smallest merit of this method of reproduction rests in the ease with which horticultural varieties or sorts of plants can, by use of it, be increased. This, as has already been stated, is the great merit of the artificial methods of reproducing plants.


Fig. IX.

The grape is usually increased from a two to three eye (bud) cutting. The cut at the base of the cutting is made close to the bud or eye, as is shown in Fig. IX, while the cut at the distal or upper end of the cutting is made at considerable distance from the top bud. The reasons for such practice are that the node represented by the bud at the base of the cutting is richer in root-forming material than that portion of the wood between the buds or nodes called the internode. The practice of leaving a portion of the internode beyond the distal bud is not so easily explained and is founded more upon tradition and science, but it may be said with some degree of truth, that the long portion of the internode left above the top bud prevents loss of moisture from that bud, and to that extent acts as a guard to the bud.

The cuttings as prepared are tied in bunches (butts all one way) of from twenty-five to fifty. This is usually done while the wood is dormant during the fall and early winter, and as fast as made, the cuttings are buried, bottom end up, in a trench, which places the top buds below dangerous freezing and exposes the butts of the cuttings to the action of frost and the stimulating influence of the sun as it warms the earth in spring. In this way natural influences are taken advantage of to produce the same result aimed at by the gardener in his artificially heated greenhouse—root action is stimulated by bottom heat, while the top buds are kept dormant by a lower temperature and the exclusion of light.

The currant is handled in like manner, except that currant cuttings are usually made about eight inches long, regardless of the number of buds they contain.

As soon as planting time arrives,—the succeeding spring,—the cuttings which have been wintered as above described, are taken from the trench, the bunches broken, and the individual cuttings (Fig. X) scattered along the side of a trench, in such a way that about three inches of space remains between each cutting and the topmost bud, or buds remain at or above the surface of the soil. The soil is then placed upon the cuttings and thoroughly packed. It is as essential that the earth be firmed about a cutting as about a seed or tree.

## FORMS OF HARDWOOD CUTTINGS.

The simplest form of hardwood cutting has already been described, in speaking of the grape and currant.

*The heel cutting* shown at Fig XI consists of a portion of the present season's growth, containing from two to five or more buds with the shoulder of the branch attached. The enlarged portion of a branch at its point of origin from its parent branch, is found to be capable of developing roots, when used as a cutting, under conditions when other portions of the same branch would give an indifferent plant or none at all.

*Mallet cutting.* The name of this form is suggestive of its shape. It differs from heel cutting in that a portion of the parent branch, from which the one used for a cutting took its origin, is retained at the base of the cutting. This form is shown at Fig. XII. It is of especial importance where the present season's growth is too soft to make a satisfactory cutting, and also in those

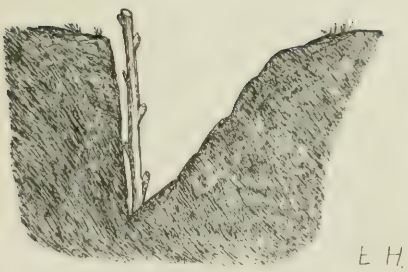



Fig. X.
(After Fuller).


Fig. XI.


Fig. XII.

cases where the plant is inclined to be indifferent to propagation by cuttings. Its merit consists in having a portion of thoroughly mature wood at its base, together with the shoulder which constitutes the chief value of the heel cutting. In both the heel and mallet cutting, the store of cambium about the shoulder and the node from which the lateral branch had its origin is believed to be the explanation for the higher percentage of success in the use of cuttings of this class.

There is a serious drawback to the commercial use of these forms of cuttings because a single heel or mallet cutting is all that can be taken from a

Fig. XIII.

lateral branch, no matter what its length. For this reason they become expensive, and the exclusive use of these styles for the propagation of plants on a large scale is impracticable.

*Single eye cuttings*—These differ from the simple cutting described above only in length, each bud is so treated that it becomes an independent plant. When mature wood is used, such as that of the grape, Fig. XIII, single eye cuttings are packed away in barrels of sand to callus. When this is successfully accomplished, they are then placed in cutting beds, either under glass or in the open, the cuttings being placed either in a reclining position with the buds up and covered with one inch of sand, or in an upright position with the buds buried about an inch below the surface, as in the former case. This is, as will have been noticed, the most economical method of multiplying plants by cuttings, and when it is desirable to produce a large number of plants from a limited supply of wood, this is the propagator's only resort. It is in its field as economical as budding in the art of grafting.

GRAFTING.

"Grafting is the process or operation of inserting a scion into a stock."

*Cion or Scion*—"A portion of a plant inserted upon the same or another plant with the intention that it shall grow."

The wood for scions like that for hardwood cuttings must be taken while in a dormant or resting condition. The time usually considered best is after the leaves have fallen, but before severe freezing begins in early winter. The scions are then tied in bunches and buried in moist sand where they will not freeze and yet be kept cold enough to prevent germination. Good results often follow cutting scions in the spring just before or at the time the grafting is to be done. If cleft-grafting is the style employed this practice frequently gives good results, but spring cutting of scions for whip-grafting, i. e. root-grafting, is not desirable, as not enough time is given for proper healing of the wound before planting time in the spring.

Were all forms of the art of grafting to be taken from the horticulturist today commercial fruitgrowing in its high state of perfection would decay with the orchards now standing.

All horticultural varieties or sorts of fruits belonging either to the pomes, drupes, or citrous classes, are now multiplied by budding or grafting. These arts are really the cornerstones upon which the entire horticultural superstructure of today rests. The progress in plant-breeding and the great rapidity with which new sorts are now disseminated, could not be attained without the aid of budding or grafting. Under existing conditions it is not

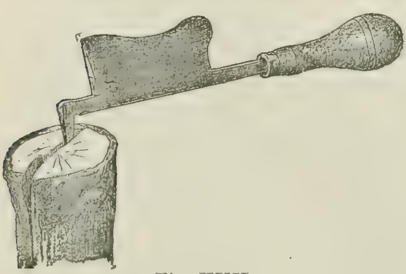


Fig. XVII.

necessary for the originator of a new sort of apples to give any thought to the question of fixing that type so it may be reproduced from seed; the method of reproducing the sort does not enter as a factor in his efforts to secure the desired variation. Grafting or budding has settled that long ago, but were it otherwise horticulturists would be studying different problems and the nurseryman would be more of a scientist than a manufacturer.

*Cleft Graft.* This style of graft is particularly adapted to large trees when for any reason it becomes necessary to change the variety. Branches too large to be worked by any of the methods hereafter described can be grafted by this method.

Fig. XIX.

A branch one or one and one-half inches in diameter is severed with a saw. A second cut should generally be made a few inches below the first one, in order that the bark shall not be loosened from any portion of the stub. Split the exposed end with a broad, thin chisel or implement, such as shown in Fig. XVII; then with a wedge or the wedge-shaped prong at the end of the grafting tool, spread the split stock so the scions shown at Fig. XVIII may be inserted. The completed operation is shown at Fig. XIX.

The scion should consist of a portion of the previous season's growth of the variety to be propagated, and long enough to have two or three buds. In general, it is a good plan to cut the scion so that the basal or proximal bud shall be located just at the base of the opening of the triangle formed in cutting the scion into the wedge shape necessary in this style of graft. The situation of the bud is shown at *a*, Fig. XVIII. In addition to the advantage of having the proximal bud located as above described, the wedge of the scion should be made thicker on the side to face outward when the scion is in position as shown at *b*, Fig. XVIII. The advantage of this will be noted from Fig. XX, which shows how the pressure of the stock is brought upon the outer growing parts of both scion and stock, whereas, were the scion thicker on the inner side, the conditions would be reversed and the death of the scion would follow: there would be no flow of sap from stock to scion, as the contact would be between heart-wood and growing wood, instead of between two growing layers. The importance of having an intimate connection between the growing tissues of both scion and stock cannot be too strongly emphasized, for upon this alone the success of grafting depends. To make this contact of the growing portions doubly certain, the scion is often set at a slight angle with the

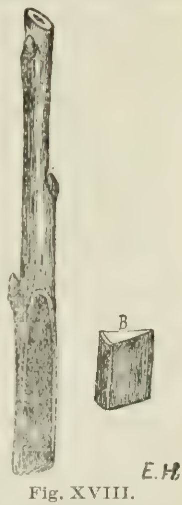



Fig. XVIII.

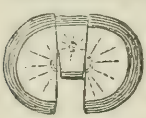


Fig. XX.

stock into which it is inserted, in order to cause the growing portions of the two to cross.

*Grafting wax*—In this climate a soft wax is not desirable for exposed work. Soft wax may be used in whip-grafting, but in cleft-grafting, where all wounded surfaces are exposed to the weather, a hard wax, made by melting together five pounds resin, two and a half pounds beeswax, and one-half pound of tallow, or one-half pint linseed oil, is preferable.

Waxing is quite as important as a proper adjustment of the scions. This consists in covering all cut or exposed surfaces with grafting wax, grafting clay, or some non-corrosive substance which will exclude air and moisture. The wax may be applied hot, with a brush, but the safest plan is to spread it with the hand while it is only sufficiently heated to allow it to be worked like taffy. If spread carefully over all cut surfaces and pressed closely, upon cooling it will form a sleek coating quite impenetrable to air and moisture.

*Waxed string*—The wax for this purpose should be a softer wax than that to be used on parts above ground, hence the following is preferred: Resin four parts by weight; beeswax two parts: tallow one part. Heat until all parts go into solution, then pour into a pail of cold water. Work in the hands until all lumps have been softened and the mass is of uniform consistency. This will be found to be an excellent wax for cool climates, as well as a superior one for soaking knitting cotton to bind stock and scion together in whip, saddle or veneer grafting. Melt a portion of the wax above described in a convenient receptacle and dip a ball of No. 18 knitting cotton into the molton wax, leaving it long enough to become thoroughly soaked; remove to allow it to cool and the waxed twine is ready for use. If preferred, strips of muslin or other light cloth can be soaked in the molten wax and used as a substitute for the waxed cord. In general, however, it is believed that the waxed knitting cotton will be found most convenient.

*Whip-grafting*—This style of grafting is the one most universally used in root-grafting. It has the advantage of being well adapted to small plants only one or two years of age, as well as the other great consideration that it can be done indoors during the comparative leasure of winter.

The graft is made by cutting the stick off diagonally—one long, smooth cut with a sharp knife, leaving about three-fourths of an inch of cut surface, as shown in Fig. XXI, which is ideal. Without changing the stock, place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the part in the direction of its long axis. Cut the reverse end of the scion in like manner, as shown in Fig. XXII, and when the two parts are forced together, as shown in Fig. XXIII, the cut surfaces will fit neatlytogether and one will nearly cover the other, if scion and stock are of the same size. A difference in diameter of the two parts to be united may be disregarded, unless it be too great. After the

Fig. XXI. Fig. XXII Fig. XXIII.

scion and stock have been locked together, as shown in Fig. XXIII, they should be wrapped with five or six turns of waxed cotton, in order that the parts may be held firmly together.

The root or stock may be left any convenient length, from two and a half to six inches, and the scion cut accordingly. In general, the shorter the root the longer the scion, and vice versa. The practices of the more rigorous climates tend to short piece roots and long scions. At planting time the whip graft, when used upon small stocks, should have the scion covered as well as the stock, the topmost bud of the scion, if any, left above the soil. If the graft is to be exposed, it should be covered with waxed muslin, or with the harder wax above described. When deeply planted, either in a furrow or with a dibble, the waxed cotton will be ample.

### BUDDING.

*Budding*--There are numerous styles of budding, but here the one in most common use will be described.

Budding is one of the most economical forms of artificial reproduction, and each year witnesses its more general use. Some nurserymen have gone so far as to use it as a substitute for all other modes of grafting, save whip-grafting, in the propagation of the dwarf pear. Budding is economical in the amount of wood used from which to take buds or scions. In this method a single bud does the work of the three or more upon the scion of the cleft or whip graft. But while it is economical of wood, it is expensive in the use of stocks, a seedling being required for each tree, while with the piece-root system of grafting, two, three, or more stocks can be made from a single seedling. The operation is simple and can be done with great speed by expert budders. The expense of the operation is, therefore, not more than that of whip-grafting, although the work has, usually, to be done in July, August, or early September. The usual system is for a man to set the buds, he being followed closely by a boy who does the tying.

Budding, then, is the operation of inserting a bud or bud scion into a stock. This is literally true, as the bud is usually inserted under the surface of the bark of the stock, as shown in Fig. XXVIII.

Fig. 24.

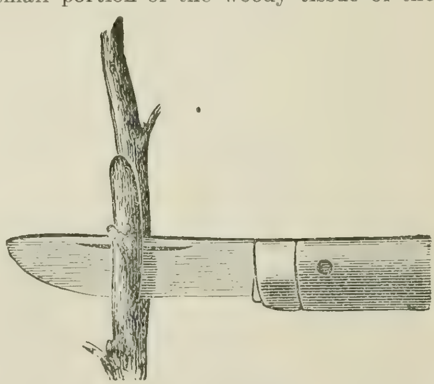
Fig. XXV.

Fig. XXVI.

Fig. XXVII.

The bud is taken from wood of the present season's growth. Since the work of budding is usually done during the season of active growth, the bud sticks are usually prepared so that the petiole or stem of each leaf is left attached, to serve as a handle to aid in pushing the bud home when inserting it beneath the bark of the stock. A bud stick is shown in Fig. XXIII, and a detached bud ready for use in Fig. XXV. This is what is usually called a shield bud, and is cut so that a small portion of the woody tissue of the

Fig. XXV., A.



Fig, XXV., B.

NOTE — Figs. 20, 21, 22, 23, 24, 25 *a*, and 25 *b*, from *Thomas' American Fruit Culturist*, by permission of publishers, William Wood & Company.

branch is removed with the bud. The operation of cutting the bud is illustrated in Figs. XXV, A and B.

The stock for budding should be at least as thick as the ordinary lead pencil. With the apple and pear a second season's growth will be necessary to develop this size, while with the peach a single season will suffice. i. e., peach stocks can be budded the same season the pits are planted; consequently the peach is left until as late in the season as is practicable, in order to obtain suitable sizes of stock.

The height at which buds are inserted varies with the operator. In general, the nearer the ground the better. The cut for the reception of the bud is made in the shape of a letter T (see Fig. XXVI). Usually the cross-cut is made at a slight angle with the body of the tree instead of at right angles to it, and the stem to the T starts at the cross-cut and extends towards the root for an inch or more. The flaps of bark caused by the intersection

Fig. XXVIII.

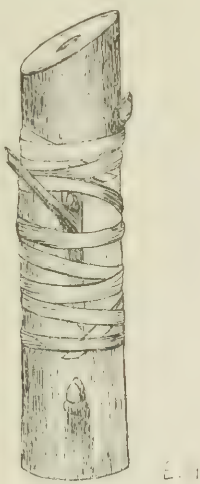


Fig. XXIX.

Fig. XXX.

of the two cuts, Fig. XXVII, are slightly loosened with the ivory heel of the budding knife, and the bud, grasped by the leaf-stem as a handle, is placed under the flaps and firmly pushed in place until its cut surface is entirely in contact with the peeled body of the stock. (See Fig. XXVIII). A ligature is then tightly drawn about, above, and below the bud to hold it in place until a union shall be formed. Such a bandage is shown in Fig. XXIX. Bands of raffia about eight or ten inches long make a most convenient tying material. As soon as ths buds have united with the stock (taken) the ligature should be cut in order to prevent girdling the stock and bud. This done, the operation is complete until the foliowing spring, when all the trees in which the buds have taken should have the top cut off just above the bud, as is shown in Fig. XXX, in which the upright shoot represents the growth from the bud. This forces the entire strength of the

root into the bud, and since the root itself had not been disturbed by transplanting, a more vigorous growth usually results from the bud than from scions in whip or crown-grafting.

The one objection to budding is that it causes an unsightly crook in the body of the tree, unless the tree is planted deeply enough in the orchard to cover the deformity. In rigorous climates, where trees upon tender roots are likely to suffer from severe winters, a bud of a hardy sort upon a tender root is no hardier than the root, because budding leaves a portion of the stock exposed above the surface of the soil and thus precludes the possibility of the development of roots from the portion above the bud: while a piece root grafted tree with a long scion is practically the same as a tree propagated from a cutting, as the scion will strike root and the new plant will be upon its own root. In regions where severe winters do not enter as a factor, there is undoubtedly a number of reasons why budding will be the most desirable method of reproducing horticultural varieties.

### PRUNING AT PLANTING TIME.

As has already been remarked, the ease of after training of a tree is, to a great extent, determined by the treatment it has received during its life in the nursery. Important as this early training is, the care and management of the tree at and after planting time more emphatically determines its value to the orchardist.

The growth made during the first three years by young trees transplanted from the nursery, to a large measure, determine the later value of the orchard as a fruit producer, as well as the length of its life. Aside from cultivation, there is no one operation connected with the maintenance of young trees which so largely determines these after conditions as pruning.

Just here it is pertinent to make a distinction between pruning and trimming.

Pruning is the removal of dead or superfluous parts, or cutting to correct a bad habit of growth.

Trimming is the removal of parts, in order to induce growth in a certain direction, so that the plant may be made to assume a form different to that natural to it.

Pruning is practiced by the orchardist in removing crossing twigs, shortening or heading in peaches, etc.: while trimming is what the vineyardist practices when he cuts his vines into desired form, in order that he may train them in a given manner. Another example of trimming, by far too common in this country, is the fantastically shaped evergreens and hedges of various sorts.

Pruning is a corrective art, while trimming is directive. At planting time both these operations are brought to bear upon the young tree. The roots are pruned, all broken and torn portions are cut away, any dead or superfluous parts are also removed. The top, however, frequently requires severe trimming. The balance between root area and the number of branches, as well as their extent, should be carefully guarded. It is better to err on the side of too little top expanse, than on the side of too small a

root area. The root system of a tree is comparable to the boiler of an engine. A twenty-horsepower engine with a ten-horse boiler is capable of doing only patial duty, so a tree lacking roots is only capable of making a feeble growth when the demands of the branches cannot be fully met. An insufficient food system means a partial food supply, lack of moisture, weak and unsatisfactory growth, which invites the attacks of insects and fungus diseases.

Good culture and rational pruning will overcome such drawbacks, when good stock is at hand to begin with.

Fig. XXXI.

Fig. XXXII.

*Trimming the top* —If the whole of the top carried by a tree as it stands in the nursery were to be retained when it is planted in the orchard, the lessened root surface, together with the unsettled condition of the roots, would soon prove that the balance between root and top had been interfered with, and that the tree was top-heavy. The demand of the expanding leaves and growing branches would soon prove too great for the reduced and dis-

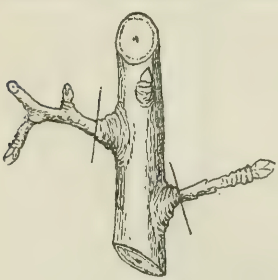
turbed root system. To overcome this difficulty is one of the primary objects of trimming, but where this is the only motive, the operation would fall quite as naturally under the category of pruning as of trimming. The height of the head, as well as the number of main branches, of the future tree is determined by trimming at planting time. An apple tree, as it came from the nursery, is shown at Fig. XXXI. The root system is ample, but somewhat deformed; the branches are of moderate growth, but too much like whips in character, and there are more of them than we desire the tree to bear in the orchard. As shown in Fig. XXXII, the deformed portion of the root system has been cut away, and superfluous branches removed; the three retained, shortened to about eight or ten inches in length.

The branches retained to form the head, it will be noticed, are distributed equi-distant about the trunk, and at different heights upon it. A line drawn through the ends of these branches would describe a circle, and the points where the branches touch the circle would divide the arc into three nearly equal segments.

The novice may think three to be far too few branches, but it will be found amply sufficient, if growth during later years is properly directed.

How shall the cut be made in removing these branches?

This is a much more pertinent question than at what season shall the cut be made, although in removing large branches from old trees, the season becomes a much more important consideration. Cut as close to the point of origin as possible. Do not leave a stub, as it will die back, decay will follow, and injury may be done to the heart-wood which will result in premature death to the tree. Fig. XXXIII shows the attachment of a branch to its parent branch. The enlargement which braces and strengthens it is very noticeable. Besides the function of giving greater strength to the angle of the branch, it is found that if the cut in removing the branch is made through this enlargement, decay seldom follows, while the wound quickly heals. If, however, the cut is made one or more inches from this enlargement decay is sure to follow and the rottening heart-wood of the dead branch carries its injuries past the enlargement at the base of the branch on the heart-wood of the parent. This opens a suitable entrance for destructive insects, as well as invites birds that nest in such hollows. The result of all this is that the decay which was originally set up by a careless tree pruner is being aggravated constantly by these outside agents, and the period of usefulness of the tree lessened.



Fis. XXXIII.

Small wounds heal more readily than large ones.

Never remove large limbs unless it is necessary.

Prune while the cut can be made with the pruning knife, and the injurious results of rot and insect depredations can be avoided.

# FOREST RESOURCES OF OREGON.

By Martin W. Gorman.

The value of our forests is three-fold, viz: First, as a source of lumber supply; second, as a source of fuel supply; and third, as the prime factor in the conservation of the flow of streams by retarding the melting of the winter's snow, thus preventing freshets with their accompanying erosion in spring, and the drying up of streams and desiccation of the soil in summer. It is only within the province of this article to deal with the first two of these questions however; and, with this object in view, let us first consider the forest as to its lumber capacity.

The fact is not generally known, even in this state, that Oregon possesses a much greater amount of standing timber than any other state in the union at the present time, viz, two hundred and thirty-four billion six hundred and fifty-three million feet, board measure.

This estimate, let me say, is not mere guesswork, nor the theorizing of an optimistic logger or lumberman, but the result of a series of thorough and systematic cruisings carried out under the direction of the United States Geological Survey, the collecting and tabulating of the data being done by Mr. Henry Gannett, Chief of the Division of Geography and Forestry.

To more fully comprehend the enormous value of this forest wealth, let us compare it with the amount of lumber cut in this state in the course of the past year.

During the year 1899, the sawmills of Oregon—of which there are now more than three hundred—cut six hundred and sixty-nine million six hundred and fifty thousand feet, valued at $6,228,250. At this ratio the value of our present standing timber, when cut into lumber, would equal the enormous total of $2,182,000,000. Nor is this all, for the above estimate only includes the seven leading timber trees, viz, Douglas spruce or red fir (*Pseudotsuga mucronata*), Tideland spruce (*Picea Sitchensis*), Pacific red cedar (*Thuja plicata*), sugarpine (*Pinus lambertiana*), western yellow pine (*Pinus ponderosa*), noble fir (*Abies nobilis*), and western hemlock (*Tsuga heterophylla*), while there are fifty-four other trees of economic value occurring in this state.

Of the above immense quantity of standing timber in our state, considerably more than one-half is contained in seven counties (all of which, with the exception of Klamath, are in the humid region west of the Cascade Range), as follows:

| *Counties.* | *Feet.* |
|---|---|
| Lane | 28,600,000,000 |
| Douglas | 23,854,000,000 |
| Linn | 18,300,000,000 |
| Tillamook | 14,190,000,000 |
| Klamath | 13,834,000,000 |
| Coos | 12,926,000,000 |
| Jackson | 12,000,000,000 |
| Total | 124,204,000,000 |

Thus leaving only one hundred and ten billion, four hundred and forty-nine million feet distributed over the remaining twenty-six counties, fifteen of which are in the subhumid and dry region east of the Cascade Range.

It is quite safe to estimate that the total cut of the current year will reach seven hundred million feet, board measure, which, at present prices, will yield a value of $6,510,000.

The paper mills of the state, at a conservative estimate, are now using between five and six million feet per annum, chiefly western hemlock (*Tsuga heterophylla*), Great Silver fir (*Abies grandis*), poplar (*Populus tremuloides*), and cottonwood (*P. trichocarpa*): and it will be safe to say that this amount will be increased rather than diminished as time goes on.

In considering our forests as a source of fuel supply, we find that one of the transcontinental lines in Oregon uses wood entirely on its trains, while all the steamers in the state are similarly fueled, and these two items, together with the amount used by our cities and towns, reaches a total of four hundred thousand to five hundred thousand cords per annum at present, a consumption that will undoubtedly be increased as the resources of the state are developed. Too many, even amongst well-informed people, are inclined to regard our timber supply as inexhaustible, and to look upon our forests as a crop that nature will replenish about as rapidly as it is consumed. The idea is a very erroneous one, and it is but fair to our more intelligent citizens to assume that when they are fully apprised of the importance of forest preservation, indifference will become a thing of the past and the subject will receive the attention to which it is entitled.

One too often hears the statement made by persons presumably capaple of knowing, that "there is just as much timber in this state now as there was when the first white settlers came here," the theory being that the growth of Douglas spruce is so rapid as to counterbalance the amount of timber used as lumber, the amount used for agricultural purposes, and the amount destroyed by fire each year. This is a serious misconception, and it is the duty of those better informed to correct such a fallacious theory as rapidly as possible.

It is quite true this tree is a very rapid grower, and that in favorable localities — say a soil of basaltic origin, coupled with a humid climate and moderate temperature, conditions that are fairly well supplied in the section of this state west of the Cascade Range — trees of this species may be found large enough for railroad ties, at forty years old, but usually they would require to be eighty years old or more to be large enough for this purpose; and, to be suitable for lumber purposes, an age of two hundred to three hundred years is necessary. When we reflect that thousands of the larger trees of this species now standing in this state are more than four hundred years old — a fact that any one may ascertain for himself by counting the annual growths on a stump five feet or more in diameter — the fallacy of regarding the forest as a crop that can be readily regrown or replaced, can be fully realized.

On the other hand, it is almost equally erroneous to regard our forests solely as a park or game preserve. They are one of the resources of our state, and a most important one, as a study of the above figures will show;

and the proper cutting and removal for lumber purposes of fully-grown or mature trees, instead of being an injury is in reality a benefit to the forests, by giving room and admitting more light to the young trees and saplings. The most dangerous enemy against which we have to contend is the "forest fires," and our first duty in regard to the forest is the prevention of forest fires and the removal of their causes. In this respect an important step in the right direction was taken when in 1897 the federal government constituted some of our principal forest reserves, and it is due to the present Commissioner of the General Land Office, Hon. Binger Hermann, to Superintendent S. B. Ormsby, and to the forty rangers in the service in Oregon, to say that the system of forest patrol has fully demonstrated the feasibillty of preventing forest fires and saving one of our chief resources from useless destruction.

In order to more clearly demonstrate the variety and value of our numerous forest trees of economic importance, it may be well to classify them, giving the botanical and common names of each with their range and chief uses. To do this properly, I will therefore enumerate them according to the natural system of Engler and Prantl.

Of the sixty-one species occurring in Oregon or on its immediate borders, thirty-four are cone-bearers and twenty-seven hardwood trees, which are included in fifteen orders and twenty-nine genera, as follows:

PINACEÆ.
- *Pinus Lambertiana* Dougl., Sugar Pine.
- *P. monticola* Dougl., Mountain White Pine.
- *P. flexilis* James, Limber Pine.
- *P. albicaulis* Engelm, White-bark Pine.
- *P. Balfouriana* Murr, Foxtail Pine.
- *P. ponderosa* Dougl., Western Yellow Pine.
- *P. Jeffreyi* "Oreg. Com.," Black Pine.
- *P. contorta* Loud, Twisted Pine or Western Scrub Pine.
- *P. Murrayana* "Oreg. Com.," Lodgepole Pine.
- *P. Coulteri* Lamb., Coulter Pine.
- *P. attenuata* Lemmon, Knobcone Pine.
- *Larix occidentalis* Nutt., Western Larch or Tamarack.
- *L. Lyalli* Parl., Lyall Larch.
- *Picea Engelmanni* Engelm., Engelman Spruce.
- *P. pungens* Engelm., Blue Spruce.
- *P. Sitchensis* (Bong.) T. & M., Tideland Spruce.
- *P. Breweriana* Watson, Weeping Spruce.
- *Tsuga neterophylla*, Western Hemlock.
- *T. Mertensiana*, Alpine Hemlock.
- *Pseudotsuga mucronata* (Raf.) Sudw. Douglas Spruce.
- *Abies lasiocarpa* (Hook) Nutt., Alpine Fir.
- *A. grandis* Lindl., Great Silver Fir.
- *A. concolor* (Gord.) Parry, White Fir.
- *A. concolor Lowiana* (Murr.) Lemmon Pale-leaf White Fir.
- *A. amabilis* (Loud.) Forbes, Amabilis Fir.
- *A. nobilis* Lindl., Noble Fir.
- *A. magnifica* Murr, Red-bark Fir, or Shasta Fir.
- *Sequoia sempervirens* (Lamb.) Endl., Redwood.
- *Libocedeus decurrens* Torr., Incense Cedar.
- *Thuja plicata* Don., Pacific Bed Cedar.

MYRICACEÆ.
- *Myrica Californica* Cham., California Wax Myrtle.

SALICACEÆ.
- *Populus tremuloides* Mx., Aspen or Poplar.
- *P. balsamifera* L., Balm of Gilead or Balsam Popular.
- *P. trichocarpa* T. & G., Black Cottonwood

BETULACEÆ.
- *Betula occidentalis* Hook., Western Birch.
- *Alnus rhombifolia* Nutt., Mountain Alder.
- *A. Oregona* Nutt., Red Alder.
- *Corylus Californica* (Adel.) Heller, Hazel.

FRAGACEÆ.
- *Castanopsis chrysophylla* (Hook.) Adel., Goldleaf Chinquapin.
- *Quercus Garryana* Dougl., Pacific Post Oak.
- *Q. chrysolepsis* Liebm., Canon Live Oak.
- *Q. Californica* (Torr.) Cooper, California Black Oak.
- *Q. densiflora* H. & H., Tanbark Oak.

LAURACEÆ.
- *Umbellularia Californica* (H. & A.) Nutt. California Laurel.

ROSACEÆ.
- *Cercocarpus ledifolius* Nutt., Mountain Mahogany.

POMACEÆ.
- *Malus rivularis* (Dougl.) Roem., Oregon Crab-apple.
- *Cratægus Douglasii*, Lindley, Western Haw.

DRUPACEÆ.
- *Cerasus emarginata* Dougl., Bitter Cherry.
- *C. mollis* Dougl., Woollyleaf Cherry.
- *C. demissa* Nutt., Western Choke Cherry.

ACERACEÆ.
- *Acer macrophyllam* Pursh., Oregon Maple.
- *A. circinatum* Pursh., Vine Maple.

RHAMNACEÆ.
- *Rhamnus Purshiana* deC., Chittimwood or Bearwood.

CORNACEÆ.
- *Cornus Nuttallii* Aud., Western Dogwood.

*Chamæcyparis Nootkatensis* (Lamb.) Spach., Yellow Cedar.
*C. Lawsoniana* (Murr.) Parl., Port Orford Cedar.
*Juniperus Virgininana* L., Red Juniper.
*J. occidentalis* Hook., Western Juniper.
TAXACEÆ.
*Taxus brevifolia*, Nutt., Pacific Yew.
ERICACEÆ.
*Arbutus Menziesii* Pursh., Madrona.
OLEACEÆ.
*Fraxinus dipetala* H. & A., Shrubby Fringe Ash.
*F. Oregona* Nutt., Oregon Ash.

## CONE-BEARING TREES.

*The Pines*—The cone-bearing trees are unquestionably the most important on the North American Continent, and among these the genus *Pinus* is easily the first in economic value. Of this genus eight species are to be found in Oregon and three others are reported to occur on the borders of the state.

In the natural arrangement the cone-bearers are as follows:

### SUGAR PINE.
(*Pinus Lambertiana* Dougl.)

The largest of all the pines, ranging from one hundred and twenty to two hundred and fifty feet in height and from four to twelve feet or more in diameter. Leaves, five in a fascicle, one and one-half to two inches long: cones, ten to eighteen inches long, and in California specimens have been found twenty-two inches long. The cones produce a soft-shell, edible nut. The lumber is straight grained, easily worked, very light, white, and compares favorably with the best white pine of the northeastern states and Canada.

*Range*—California to the Santiam Valley, Oregon. In this state it occurs mostly on the northern slopes of the Siskiyous, and in Jackson, Josephine, Klamath, Douglas, and Lane counties; the two first-named counties containing the greatest quantity of this magnificent tree.

*Use*—Makes excellent finishing lumber, and, being free from knots, is much in demand for sash, doors, blinds, oars, etc.

### MOUNTAIN WHITE PINE.
(*P. Monticola* Dougl.)

A much smaller tree than the preceding, yet larger than the average white pine of the east, sometimes reaching one hundred and fifty feet in height and five feet or more in diameter. A very graceful tree, maintaining its diameter well up towards the crown and being fairly free from limbs for a great part of its height, it is an ideal lumber tree wherever found. It has a greater altitudinal range and is capable of sustaining more cold than the sugar pine, and consequently is to be found much farther north. Leaves, five in a fascicle, one and one-half to two inches long; cones, narrow, six to ten inches long, and producing a seed.

*Range*—California to British Columbia.

*Use*—Sash, doors, lumber and fuel.

### LIMBER PINE.

(*P. flexilis* James.)

A subalpine tree mostly confined to the Rocky Mountains. Usually more or less depressed when found about the upper limits of its altitudinal range, but making very serviceable lumber and mine timber at lower elevations. It is the principal timber tree of Utah and Nevada. Leaves, five in a fascicle one and one-half to two inches long; cones, two to four inches long. Reported to occur in Wallowa County, Northeastern Oregon.

### WHITE-BARK PINE.

(*P. albicaulis*, Engelm.)

The most alpine in habitat of all the pines, usually found about the extreme tree limit on all the mountains of Oregon, consequently a much depressed tree rarely exceeding thirty feet in height or three feet in diameter. Though close grained and of firm texture, it is seldom, if ever, used for lumber owing to its inaccessibility. Its alpine habitat and consequent freedom from forest fires enables this tree to attain a great age, some veterans showing the extreme age of seven hundred to eight hundred years. Leaves, five in a fascicle, one and one-half to two inches long; cones, one and one-half to three inches long, producing a soft-shell nut that is much eaten by Clark's Crow (*Nucifraga Columbiana*).

*Range*—California to British Columbia, north latitude 53°.

*Use*—Fuel. Nuts, edible.

### FOXTAIL PINE.

(*P. Balfouriana*, Murr.)

A comparatively rare pine definitely known only from a few spots in the Sierra Nevada and in North California near Mount Shasta. Leaves, five in a fascicle, one to two inches long; cones, three to five inches long. Reported to occur in the Siskiyou Mountains, Southern Oregon.

### WESTERN YELLOW PINE.

(*P. Ponderosa*, Dougl.)

A magnificent tree almost equalling the sugar pine in size. It ranges from one hundred to two hundred feet in height and from three to ten feet in diameter. Bark very thick, thus affording a certain amount of protection from forest fires; deeply fissured into large plates and flaking off at the base of the tree, giving it a yellowish or yellowish-red appearance.

This is the only pine tree to be found growing naturally within the city limits of Portland, and to its presence therein Pine Street owes its name. Leaves, usually three inches in a fascicle, five to ten inches long; cones, conical-ovate in shape, two and one-half to five and one-half inches long, and producing seeds.

*Range*—California to Fraser and Columbia River valleys in British Columbia, north latitude 50°, 7′.

*Use*—In great demand for lumber in Eastern and Central Oregon, inside finishing, laths, farm buildings, fuel, etc.

### BLACK PINE.

(*P. Jeffreyi* "Oreg. Com.")

This tree bears a considerable resemblance to *P. ponderosa*, but favors a drier climate, has a greater altitudinal range, longer foliage and larger cones. The bark is also finer checked and darker, thus giving rise to the common name "black" pine. Leaves, three in a fascicle, five to nine inches long; cones, large, six to ten inches long, producing a seed.

*Range*—Lower California (Mexico) to Central Oregon.

*Use*—Lumber, fuel, and pitch, the latter being used to a considerable extent in medicine.

### TWISTED PINE OR WESTERN SCRUB PINE.

(*P. Contorta* Loud.)

A typical coast tree, usually depressed and twisted by the coast gales, thus accounting for the common names "twisted" pine, "scrub" pine. Nevertheless, when it occurs in sheltered nooks in Oregon or Washington, or in sphagnous marshes in South Alaska, where it is protected from the winds, it is found to be a straight-grained tree, reaching seventy feet in height, and serviceable for many economic purposes. It is closely allied to *P. Murrayana*, but favors a much lower elevation, a moister climate, contains more pitch, and has a much thicker bark than the latter. Leaves, two in a fascicle, one and one-half to two and one-half inches long; cones, one to three inches long, producing a seed.

*Range*—California to Southern Alaska, along the coast.

*Use*—Farm purposes, fuel, etc.

### LODGEPOLE PINE.

(*P. Murrayana* "Oreg. Com.")

A slender, graceful tree of middle elevations, ranging in altitude from fifteen hundred to six thousand feet in Oregon and Washington. Attains a height of sixty to one hundred and ten feet and a diameter of ten to twenty-two inches. Largely used for fuel in some localities in Eastern Oregon, as much as twenty thousand cords per annum being shipped from a single station on the Oregon Railroad & Navigation Company's lines. The wood contains less pitch and the bark is much thinner (one-quarter to one-half an inch) than that of its near congener, *P. contorta*, the latter peculiarity leaving the tree an easy prey to forest fires. Leaves, two in a fascicle, one to two inches long; cones, one and one-half to two and one-half inches long, producing a seed.

*Range*—California to Fort Selkirk, Yukon Territory, north latitude 62°, 47′.

*Use*—Farm buildings, fuel, etc.

### COULTER PINE.

(*P. Coulteri* Lamb.)

A tree of medium height and limited range, apparently confined to the Coast Range and San Bernardino Mountains. It is evidently barred on the south by aridity and on the north by cold, and is noted for having the longest

foliage and largest cones of all the western pines. Leaves, three in a fascicle, ten to fifteen inches long; cones, twelve to eighteen inches long, producing a hard-shell nut. Reported as occurring in Josephine County, Southern Oregon.

### KNOBCONE PINE.

(*P. attenuata* Lemmon.)

A small subalpine tree of the Coast, Cascade, and Sierra Nevada ranges, notable for its firmly-closed cones, which are so persistent that they sometimes become completely enveloped in the growing tree. The seed is remarkable for its great vitality, specimens having been known to germinate after being kept for twenty years. Leaves, three in a fascicle, three to six inches long; cones, three to six inches long, producing a seed.

*Range*—California to Central Oregon.

*Use*—Fuel and ornamental.

### WESTERN LARCH OR WESTERN TAMARACK.

(*Larix occidentalis* Nutt.)

This deciduous and very useful conifer is, so far as yet known, confined exclusively to the eastward of the Cascade Range. This limitation is hard to account for and is certainly not due to any lack of adaptation to humid conditions, as it is well known to thrive in sections of the Bitter Root Range in Idaho, where the annual precipitation is greater than in the Willamette Valley, Oregon. Its powers of adaptation to semi-arid conditions are almost equally great, as it is known to exist in the Lake Chelan district, Washington, where the annual precipitation is only eleven and one-half inches. The trees are tall, of good size, and have a very thick bark of light-gray color. This thick bark enables the tree to survive in safety many forest fires in which adjoining species perish. The wood is dark, close-grained, of high specific gravity, and makes very fair lumber. That this, as well as several other species of the Pacific Slope, is slowly disappearing there can be no doubt, as the very limited number of saplings abundantly testifies. This disappearance is undoubtedly due to gradual desiccation of the region over which the tree ranges.

*Range*—Oregon to the Rocky Mountains: north to Columbia Lake, British Columbia, about north latitude 51°. Once reported from Blackwater River, British Columbia, north latitude 53°.

*Use*—Lumber and fuel, and in Eastern Oregon for railroad ties.

### LYALL LARCH.

(*Larix Lyalli* Parll.)

A rare and rather remarkable alpine tamarack, not yet definitely found in Oregon, but supposed to occur on some of the higher peaks of Wallowa County. Closely allied to the last-named species, but having a greater alpine range—in fact, the highest altitudinal range of any tree in the northwest. It is a tree of exceedingly slow growth, and, judging from its present scarcity, isolation, and limited production of cones and seeds, it is undoubtedly becoming extinct.

*Range*—Cascade and Galton ranges to the Rocky Mountains, at elevations of six thousand to seven thousand five hundred feet in Washington and British Columbia, and reaching nine thousand to ten thousand feet in the Bitter Root Range in Idaho.

### ENGELMANN SPRUCE.

(*Picer Engelmann* Engelm.)

This species has a greater altitudinal range (two thousand to seven thousand feet), and possesses proportionate powers of adaption to conditions of humidity and dryness, consequently it varies greatly in size. On dry ridges it occurs small, schubby and stunted, with many abortive and few fertile cones, while in moist, rich valleys it becomes a magnificent tree one hundred to one hundred and seventy-five feet in height and two and one-half to six feet in diameter, bearing large quantities of fully seeded cones which are massed near the top, thus assuring greater distribution and abundant propagation.

*Range*—Oregon to the Rocky Mountains, and north to British Columbia and the Peace River region, Athabasca, latitude 55° 47′ north.

Though not know to occur in California it has been found in Northern Arizona.

*Use*—Much used for lumber and fuel in Eastern Oregon.

### BLUE SPRUCE.

(*Pungens*, Engelm.)

A medium-sized tree noted for its very sharp foliage, hence the specific name. Not yet collected in Oregon, but reported as occurring in the southeastern part of the state.

*Range*—Rocky Mountains westward to Wyoming.

### TIDELAND SPRUCE.

(*P. Sitchensis* (Bong.) T. & M.)

One of the moisture-loving coast trees seldom found at any great distance inland and reaching the extreme limit of its altitudinal range at about three thousand two hundred feet. Though little, if any, taller than the Engelmann spruce, it grows to a much larger size, specimens of fifteen feet or more in diameter being sometimes found. When grown in the open it is pyramidal in shape, abundantly and symetrically branched, and makes a beautiful lawn tree. In the forest it is slower growing, closer grained, free from limbs for fully two-thirds of its height, and being fairly free from pitch it makes clean, serviceable lumber. It is the tree almost exclusively used for lumber and fuel in Southern Alaska. The bark is thicker than that of the Engelmann spruce. The cones, which are two to four inches long, are not so much massed at the top of the tree and probably not quite so abundant, but it nevertheless appears to propagate readily and hold its own except where removed for agricultural purposes or destroyed by forest fires.

*Range*—Northern California to Cook's Inlet, Alaska. In Oregon, Clatsop County contains the finest forests of this tree at present.

*Use*—Lumber, fuel, paper pulp, piling, barrels, boxes, shooks, excelsior, and boat building.

### WEEPING SPRUCE.
(*P. Breweriana* Wats.)

The rarest tree in the northwest, and probably the rarest on this continent, decidedly alpine in habitat, and mostly confined to the Siskiyou Mountains. It is a comparatively small tree, with long, slender, pendent branchlets, hence, the common name "weeping" spruce.

*Range*—The Siskiyou Mountains, in Northern California and Southern Oregon, and a few adjoining peaks to the northward.

*Use*—Ornamental.

### WESTERN HEMLOCK.
(*Tsuga heterophylla.*)

Moisture-loving and capable of enduring a great amount of shade without any apparent injury, this species thrives well along the coast, where it is mingled with the tideland spruce and other coast species. It can also be found following up most of the northwestern river valleys as far as the limit of the region of abundant rainfall, and it is only in these localities that it is found in pure groves by itself and attains its largest development—one hundred and fifty feet or more in height by three to five feet in diameter. It has a darker and thinner bark than the alpine hemlock and is a tree of more rapid growth. In altitudinal range it can be found from sea level to five thousand or six tousand feet elevation.

*Range*—Northwestern California to Alaska (? 60° north latitude) and eastward to the Selkirks, where it is abundant.

*Use*—Lumber, fuel, paper pulp, and tanbark.

### ALPINE HEMLOCK.
(*T. Mertensiana.*)

As the common name implies, this is decidedly alpine in habitat, ranging from about ten thousand feet on some of the mountains of California and Idaho to almost sea level in Alaska. About its upper limits, particularly on exposed ridges, it is generally scrubby and stunted, but on sheltered slopes it attains a large size, sometimes reaching one hundred feet in height by two and one-half to five feet in diameter. It is a slow grower, close grained, and if accessible would make excellent lumber. The bark is grayish-brown in color, roughly corrugated, very thick, and contains a large amount of tannin. Cones, larger than those of any other Hemlock—one and one-half to three inches long and quite noticeable in the forests, owing to their purple color.

*Range*—California to Alaska, and eastward to the Bitter Root and Rocky mountains.

*Use*—Fuel, tanbark, etc.

### DOUGLAS SPRUCE.
(*Pseudotsuga Mucronata*, (Raf.) Sudw.)

Incomparably the finest, most abundant and most useful of the many timber trees of the northwest. Sometimes, though erroneously, called

"Douglas Fig," "Red Fir," "Yellow Fir;" and in the lumber yards of California and elsewhere outside of this state, "Oregon Pine." When grown in open woods the annual growths are large, somewhat laxly adherent to each other, the limbs numerous, the quality of the timber not so good, and the wood somewhat reddish in color, giving rise to the name "Red Fir."

In dense forests the trees are much taller in proportion to diameter, fairly free from limbs, the annual growths small and compact, the quality of the timber unsurpassed and the wood close grained and yellowish, thus causing it to be called "Yellow Fir." It ranges in elevation from almost sea level to six thousand feet, and in height from one hundred and twenty to three hundred feet or more by four to ten feet in diameter. Its adaptability to varying conditions of humidity is great, being found about Neah Bay, Washington, with an annual precipitation of one hundred and twenty feet, and in the Okanogan region where the annual precipitation is only eleven and one-half inches. In the latter section and about the upper limits of its altitudinal range it is, of course, dwarfed and scrubby. The bark is deeply furrowed and very thick, thus affording great protection from forest fires. Cones, two to three and one-half inches long, numerous and fully seeded, thus insuring abundant propagation. The tree has been introduced abroad, notably in the Black Forest where it is quite thrifty. It submits readily to transplanting and cultivation, fourteen varieties having already been evolved from it by cultivators.

*Range*—New Mexico to British Columbia, north latitude 55° 15′, and eastward to the Rocky Mountains. Clatsop and Columbia counties contain the finest groves of this tree at present.

*Use*—Bridge timber, laths, lumber, piling, railroad ties, masts, spars, fuel, etc. The best and strongest cars in use on this continent at present are made of this wood.

### ALPINE FIR.

(*Abies lasiocarpa* (Hook.) Nutt.)

All the species of the genus *Abies*, of which there are seven in Oregon, are true firs, and consequently have erect cones, thus making them readily distinguishable, even to the most careless observer, from the other cone-bearing trees, all of which, with one exception, have pendent cones. This tree is the most alpine of the firs, ranging from two thousand one hundred to seven thousand feet in the Cascades, and still higher in the Bitter Roots. Cones, two to three and one-half inches long; bark, whitish and thin, leaving the tree an easy prey to forest fires.

*Range*—California to British Columbia and Athabasca, north latitude 55° 20′, and eastward to the Rocky Mountains.

*Use*—Gum is used both commercially and medicinally.

### GREAT SILVER FIR.

(*A grandis* Lindl.)

More closely confined to the coast than the last named; it is also a much larger tree and rarely ascends beyond three thousand five hundred feet elevation. It is the only fir that occurs naturally within the present city

limits of Portland. The wood is soft but straight-grained and makes a fair quality of lumber, but in the presence of so many other trees of superior quality it is only used to a limited extent. The bark is usually whitish-gray in color, thin, and, containing a large amount of gum, makes the tree an easy prey to forest fires. Cones, narrow, two to three inches long.

*Range* — Northern California to British Columbia along the coast to north latitude 51°.

*Use* — Box lumber, paper pulp, and shooks.

### WHITE FIR.

(*A. concolor* (Gord.) Parry.)

Has a more eastern and more alpine range than the great silver fir, and is capable of enduring a drier climate. In fact it is almost exclusively found to the southward and eastward of the region occupied by the latter. Being more alpine it is of slower growth and the wood is closer grained. The bark is much thicker and usually whitish, thus originating the common name "White Fir."

*Range* — Mexico (Lower California) and Arizon, north to the Columbia River and eastward to the Rocky Mountains. Occurs in the Blue Mountains, Eastern Oregon.

*Use* — Lumber.

### PALE-LEAF WHITE FIR.

(*A. concolor lowiana* (Murr.) Lemmon.)

A variety of the last-named species and closely allied to it, but having a more southern habitat and limited range and growing to a larger size. The leaves also are more up-curved than on the white fir, and the bark is darker and thicker. The wood is entirely free from pitch and more scentless than that of the other firs, consequently it is desirable for many economic purposes.

*Range* — California to Southern Oregon.

*Use* — Lumber, butter boxes, firkins, etc.

### AMABILLIS FIR.

(*A. amabillis* (Loud.) Forbes.)

Subalpine in habitat, ranging from five hundred feet in the Coast Range up to seven thousand feet or more in the southern part of the Cascades. At minimum and lower elevations it attains a large size, and makes fair lumber wherever accessible. A curious fact in connection with its altitudinal range is that it occurs at a lower elevation than the noble fir in the Coast Range, and at a higher elevation than the latter in the Cascade Range. Leaves, two-ranked and flat, somewhat resembling the foliage of *A. grandis*; cones, medium-sized, three to four inches long.

*Range*—Northern California to Salmon River and the valley of the Fraser, British Columbia, north latitude 53°, and eastward to Montana.

*Use*—Lumber, fuel, etc.

### NOBLE FIR.

(*A. nobilis* Lindl.)

Of all the common names applied to our magnificent western trees the name "Larch," ignorantly given to this tree by loggers and some lumbermen, is the most absurd and least excusable. All the larches (tamaracks) have thin, weak, deciduous foliage, and small, oval cones that are more or less pendent, while all the true firs have strong, rigid, persistent foliage, and fairly large, erect cones, so that there is no possible excuse for even the most careless observer to confuse or mistake one for the other in any way. This tree is the most desirable of all the firs for lumber purposes, and is much sought after by lumber and sawmill men wherever it can be obtained. The wood is strong, straight grained, and, being entirely free from pitch, is preferable even to Douglas spruce for furniture and inside finishing. The foliage is not so long as that of *A. grandis* or *A. amabilis*, and instead of being flat and two-ranked, is strongly up-curved. Cones, large, four to six inches long.

*Range*—Northern California to Washington as far as north latitude 48°. Occurs both in the Cascade and Coast ranges in Oregon.

*Use*—Lumber, inside finishing, furniture, fuel, etc.

### RED BARK FIR OR SHASTA FIR.

(*A. magnifica* Murr.)*

The largest of all the firs, and, next to *A. nobilis*, the most useful. As its specific name indicates, it is truly a most magnificent tree, ranging in height from one hundred and twenty to two hundred and fifty feet, and in diameter from three to six feet or more. The bark is very thick, usually dark outside but reddish inside, giving rise to the common name, "Red Bark Fir." Cones, the largest of all the firs, six to eight inches long; leaves, short, dense, and somewhat two-ranked.

*Range*—California to Southern Oregon, along the Sierra Nevada and Cascade ranges.

*Use*—Bridge timber, inside finishing, lumber, etc.

### REDWOOD.

(*Sequoia sempivirens* (Lamb.) Endd.)

Essentially moisture-loving, this tree is rarely found at any great distance from the coast. It is the principal lumber tree of California, where it is confined to the Coast Range and extends from the vicinity of Monterey, where it occurs sparingly, north to the state line. In Oregon it is found on Chetco River and a few other small tracts in Curry County, the whole area occupied by it in this state being not to exceed one to one and one-half sections (six hundred and forty to nine hundred and sixty acres). This magnificent tree undoubtedly reached its maximum development on the Pacific Coast ages

* It is claimed that this tree is confined to California, and that only its variety, *Shastensis*, occurs in Oregon, while other authorities assert that the two are really one species and that *Shastensis* is simply an alpine form of the type. This question can only be definitely decided on further investigation.

ago, and at the present time it is slowly but surely disappearing, being delimited on the south by aridity and on the north by cold. It attains a great size, two hundred to three hundred feet high by ten to twenty feet or more in diameter, reaching its densest growth in Humboldt County, and its greatest forest area in Mendocino County, California. The quantity of lumber that can be cut from a single acre of redwood forest, or manufactured from a single redwood tree, would seem incredible to one who has never had the good fortune to visit or examine a grove of these trees. A single acre in Humboldt County has been known to yield one million four hundred and thirty-one thousand five hundred and thirty feet of lumber, "board measure," while a single tree is on record as having scaled over one hundred thousand feet. The wood, when freshly cut, is decidedly red (hence the common name), but on drying this color fades to a brown. It is the only tree of the whole conifer family that possesses the faculty of sprouting and reproducing from the stump or the fallen trunk, and to this unique property it undoubtedly owes a great part of its present propagation. The bark is very thick and the cones usually small (about the size of a marble) for a tree of such grand proportions. The foliage is dark-green in color, two-ranked, and somewhat resembles that of the Pacific yew. The longest leaves are found in the middle of the season's growth, thus giving it an elliptical form on the branchlets. It has been propagated and borne fertile, seeded cones as far north as Victoria, British Columbia, while its near cogener, the "Bigtree" (*S. gigantea*), though transplanted and grown successfully at the same locality, has not yet been known to bear fertile cones even as far north as the Columbia River.

*Range*—Monterey, California, to Southern Oregon. Not yet known to occur outside of Curry County in this state.

*Use*—Lumber, inside finishing, shingles, etc.

### INCENSE CEDAR.

(*Linocedrus decurrens* Torr.)

Takes the place of the Pacific red cedar to some extent in Central and Southern Oregon, and is a very valuable tree for farm purposes. Leaves, opposite and oppressed as in all the cedars; cones, four-fifths to one and one-fifth inches long, with two fertile scales bearing two seeds each, the seeds maturing in one year. Bark on the young trees, thin, reddish and shreddy: on mature trees thick and seamed.

*Range*—California to the Santiam Valley, Oregon, the best groves being found in Jackson and Josephine counties.

*Use*—Lumber, farm buildings, fence posts, rails, etc.

### PACIFIC RED CEDAR.

(*Thuja plicata*, Don).

Judging from the variety of uses to which this is put, it is undoubtedly the most useful, though not the most valuable, tree in the northwest. It ranges in altitude from sea level to six thousand feet and attains its best development at the lower levels in moist, rich valleys and river bottoms west

of the Cascade Range. In height it ranges from ninety to one hundred and fifty feet with stump diameter of from three to ten feet or more, the largest on record measuring seventeen feet. but it will not yield as much lumber in proportion to height as spruce or firs. on accout of its tapering so rapidly towards the top. Its well known ability to resist decay in contact with the ground causes it to be much prized for farm buildings and fences, while its large size and excellent powers of flotation cause it to be equally valued by the Indians for canoes. It is the chief shingle tree of the northwest, and the quantity annually sawed into shingles in Oregon and Washington is so great that the species is rapidly diminishing. The bark is gray, seamed, and thin, but resists forest fires fairly well. The cones are quite small. have six fertile scales bearing twelve seeds or three times as many as the Incense cedar. and this prolificness coupled with the immense quantity of cones borne by it, accounts, to some extent, for its rapid propagation as compared with the latter. Heart-wood, reddish, hence the common name.

*Range*—California to Alaska and eastward to the Selkirk and Gold ranges.

*Use*—Lumber, clapboards. farm buildings. fence posts, rails. sash. doors, shingles, shakes, telegraph and telephone poles, etc.

### YELLOW CEDAR OR ALASKA CEDAR.

(*Chamæcyparis Nootkatensis* (Lamb.) Spach.)

Hardy, moisture-loving trees. ranging in altitude from sea level in Alaska to six thousand feet in Oregon and Washington, and almost entirely confined to moist mountain slopes west of the Cascade Range in this state. Though not so large a tree as the Pacific red cedar, it yet attains a fair size, reaching fifty to one hundred feet in height by two to six feet in stump diameter. It attains its greatest development in the Olympic Range, Washington. and about Nootka Sound, British Columbia. The branches are declined and the branchlets mostly pendulous. giving the tree a dejected appearance in the forest. and clearly showing its heridity and descent through countless ages from a northern and more or less alpine ancestry whose snow-laden, depressed branches have stamped their form on its posterity for all time. Bark of the young tree reddish and shreddy. becoming checked and grey in age, when it strongly resembles that of the red cedar. Cones, small, round. one-quarter to one-half inches thick. maturing in two years. Male flowers. yellowish; wood. yellowish, close grained. firm and stronger than that of any other cedar. It also takes a high polish, and its lasting, pungent odor causes it to be prized for clothes closets, chests, etc.

*Range*—Head of Umpqua Valley. Oregon, to Yakutat Bay, Alaska, north latitude 59° 45′, the finest trees in Oregon occurring in the vicinity of Mount Hood.

*Use*—Finishing lumber, cabinetwork, etc.

### PORT ORFORD CEDAR.

(*C. Lawsoniana* (Murr.) Parl.)

Beautiful, ornamental. and valuable trees of very limited range. being found only on the coast of Southwestern Oregon and in a few small groves in Del Norte County. California. Though strictly confined to the coast in

this state it is such a beautiful lawn tree and has proved so amenable to cultivation that it has been propagated in the eastern states and Europe to such an extent that no fewer than sixty-eight varieties of it are already to be found in nurseries and botanical gardens. The wood is more creamy in color, more aromatic and less pungent than that of the yellow cedar, and it is highly prized for cabinetwork and inside finishing. When grown in open woods or on lawns the tree assumes a pyramidal shape, and this, coupled with its horizontal branches and bright green foliage, combine to make it a most beautiful lawn ornament. Cones, small and globular, greatly resembling those of the yellow cedar in size and appearance, but maturing in one year. Male flowers, reddish.

*Range*—Del Norte County, California, to Coos and Curry counties, Oregon.

*Use*—Finishing lumber, cabinetwork, matches, broom handles, clothes chests, trunks, etc.

### RED JUNIPER.

(*Juniperus Virginiana* L.)

Small, conical trees of rare occurrence in Eastern Oregon, seldom exceeding thirty feet in height or twelve inches in diameter. It is one of the four (or if *Betula papyrifera* be included, five) trees that cross the continent. Branches and branchlets drooping. Cone, a small glaucus-blue, two-seeded berry or galbulus. Sapwood, white; heartwood, red, close grained, odorous and durable.*

*Range*—Oregon to the Atlantic States.

*Use*—Cabinetwork, fence posts, lead pencils, etc.

### WESTERN JUNIPER.

(*J. occidentalis*, Hook.)

Very much larger trees than the last named and much more abundant. Reaches its greatest development both in size and quantity in Eastern Oregon where individual specimens with a basal diameter of five to six feet can be found. It is a tree of very slow growth, and, though usually occuring in rather dry situations, it undoubtedly thrives best where a mild temperature and fairly humid conditions prevail. It is almost exclusively confined to the eastward of the Cascade and Sierra Nevada ranges, only a few isolated patches being found to the westward in Vancouver Island, Southern Oregon and California, and there can be no doubt from the small number of saplings to be seen, even where there are pure groves of it, that it is slowly but surely undergoing extinction from some cause, probably lack of humidity. Its restriction to the east of the range is not due to unfavorable climatic conditions on the west side, but to the more rapid growth of the other conifers preventing it getting a foothold there.

The tree bears a large quantity of berries, but a great number of them are not fertile, and propagation of them appears to be very inadequate. The berry is rather smaller than that of the preceding and darker blue in color.

* It is quite possible that upon further investigation this tree may prove to belong to a closely allied species, *J. scopulorum*.

*Range*—San Bernardino Mountains, California, (north latitude 34°), to the Columbia River Valley, British Columbia (north latitude 52°), the best groves being found in Crook and Wasco counties, Oregon.

*Use*—Lumber, fence posts, and rails.

### PACIFIC YEW.
(*Taxus brevifolia* Nutt.)

Small pyramidal trees seldom exceeding forty feet in height, but sometimes attaining a basal diameter of two feet or more. Does not occur in groves or thickets by itself like the eastern yew, but usually favors moist, sheltered gulches or stream banks. The tree is diœcious and the fruit is a small, cup-shaped, sweetish, edible berry. Leaves, dark green, short, and two-ranked. The bark is thin, reddish, and shreddy. The sapwood is exceedingly limited in amount, and the heartwood, which is reddish when freshly cut, but soon fades to a brown, is tough, elastic, and very durable.

*Range*—California to Annette Island, Alaska.

*Use*—Fence posts, fancy cabinetwork, etc.

## HARDWOOD TREES—MOSTLY DECIDUOUS.

### CALIFORNIA WAX MYRTLE.
(*Myrica Californica*, Cham.)

A small evergreen tree, rarely exceeding forty feet in height, by about two feet in basal diameter. It usually favors a moist, rich soil and sheltered locations. The wood is close grained, grayish in color, becoming darker on drying, and is valued for fancy wood turning.

*Range*—California to Puget Sound, Washinton.

*Use*—Furniture and cabinetwork. Bark and foliage are medicinal.

### ASPEN OR POPLAR.
(*Populus Trumuloides*, Michx.)

One of the most widely distributed of the deciduous trees. It ranges in altitude from sea level to six thousand feet, and makes a fair growth even in the dry, prairie regions, but thrives best on moist, rich stream banks at the lower levels, where it attains a height of one hundred feet or more, by two to three feet in diameter.

*Range*—Lower California to tree limit at the mouth of the Yukon, and to the Arctic Ocean, at the mouth of Mackenzie river. Eastward, to the Atlantic.

*Use*—Paper pulp, rails and fuel.

### BALM OF GILEAD, OR BALSAM POPLAR.
(*P. balsamifera*, Linn.)

Has not so great a regional range as the preceding, to the southward, but extends even farther to the northwest along the Yukon River. It ranges in altitude from sea level to four thousand feet, but reaches its best development on moist, rich stream banks and islands, where it may be found one

hundred and forty feet high, by six feet or more in diameter. The bark on the young tree is smooth and light grayish green in color, but on the mature tree it becomes rough seamed and gray. The wood is much superior to that of the aspen for all economic purposes.

*Range*—California to the Arctic Circle, and eastward to the Atlantic States and Canada.

*Use*—Excelsior, paper pulp, rails and fuel. On the Yukon and Pelly rivers it is much used for canoes by the Indians.

### BLACK COTTONWOOD.

(*P. trichocarpa* T. & G.)

This tree is much more limited in regional range than either of the two preceding, but has about the same altitudinal range as the balsam poplar. It favors moist, rich stream banks, where it frequently attains a height of one hundred and twenty feet or more by about six feet in diameter. In bark, size, and general appearance it resembles the balsam poplar much more than the aspen, and the wood is fully equal to that of the former for economic use.

*Range*—California to British Columbia.

*Use*—Excelsior, paper pulp, rails, and fuel.

### WESTERN BIRCH.

(*Betula occidentalis* Hook.)

The western birch is mostly confined to valleys east of the Cascade Range, not because of any lack of favorable conditions of growth on the west side but chiefly owing to the more rapid and luxurant growth of the conifers crowding it out of the forest there. Under favorable conditions it attains a height of ninety feet and a basal diameter of one and one-half to two feet. The bark varies so much in color (all the way from a whitish-gray to a dark-brown) that the tree is sometimes called "White Birch," "Black Birch," etc. The wood is dark, close grained, takes a high polish, and is valued for certain kinds of cabinetwork.

*Range*—California to British Columbia and eastward to Edmonton, Alberta.

*Use*—Furniture, cabinetwork, and, when young, for barrel hoops.

### MOUNTAIN ALDER

(*Alnus rhombifolia* Nutt.)

A much smaller tree than the red alder, ranging from twelve to fifty feet in height and from six to eighteen inches in basal diameter. It has a more restricted regional range but a greater altitudinal range than the latter.

*Range*—California to British Columbia and eastward to the Selkirks.

*Use*—Furniture, fuel, etc.

### RED ALDER.

(*Alnus Oregona* Nutt.)

The alder is commonly supposed to be a small tree or shrub, but this one is a notable exception, and in a favorable habitat attains a height of one

hundred feet by three to four feet in stump diameter. It usually prefers moist slopes or stream banks and humid conditions, but will thrive fairly well even in subhumid surroundings. The bark is comparatively thin, and on the mature tree it becomes seamed and rough. Before maturing the male flowers are somewhat reddish, hence the common name, red alder.

*Range*—California to Alaska.

*Use*—Buggy boxes, furniture, fuel, etc.

### HAZEL.

(*Corylus Californica* (A. de C.) Heller.)

Though only a shrub, this attains a fair height, six to twenty feet by three to six inches in basal diameter, and it has several economic uses. In pioneer times in this state it was the wood used for home-made brooms—the only article of the kind to be had in those days—just as elm was formerly used on the Atlantic Coast, and as birch is used at the present day on the Yukon. To the credit of the hardy pioneer housewife be it said the humble homes of those days were more cleanly swept than many of the pretentious residences of the present time, where such work is considered beneath the new woman, and is usually consigned to a pig-tailed celestial from the Flowery Kingdom or a tow-headed kitchen autocrat from the banks of the Rhine or the Swart.

*Range*—California to British Columbia.

*Use*—Wood for shoe-pegs, baskets, and barrel hoops. Nuts edible

### GOLDENLEAF CHINQUAPIN.

(*Castanopsis chrysophylla* (Hook.) A. D. C.)

Handsome, medium-sized, evergreen trees, closely allied to the oaks. In favorable locations it attains a height of fifty to sixty feet by ten to twenty inches in basal diameter. The wood is not only valued for cabinetwork, but the tree itself is well adapted for lawn ornamentation, and the nuts are edible. It has the misleading name of "California walnut."

*Range*—California to the Columbia River.

*Use*—Furniture and cabinetwork. Nuts are edible.

### PACIFIC POST OAK.

(*Quercus Garryana* Dougl.)

One of the white oaks usually preferring a moist, rich soil, where, under favorable conditions, it attains a height of sixty to ninety feet, and basal diameter of four feet. The sapwood is large in amount, and in moist situations the tree is a rapid grower. The bark is finely checked and light-gray in color. The wood is heavy, compact and durable, and is prized for inside finishing.

*Range*—California to British Columbia.

*Use*—Furniture, inside finishing, wagonwork, fuel, etc.

### CANON LIVE OAK.

(*Q. Chrysolepis* Liebm.)

An evergreen tree, much smaller than the preceding, but in favorable locations attaining a fair size—say fifty to seventy-five feet high, and

twelve to thirty inches in diameter. The tree is of slow growth and the wood more compact than that of *Q. Garryana*, and for some purposes it is preferable to the latter.

*Range* — Oregon and California.

*Use* — Wagonwork, tool handles, pack saddles, etc.

### CALIFORNIA BLACK OAK.

(*Q. Californica* (Torr.) Cooper.)

The largest of our native oaks, sometimes attaining a height of seventy-five to one hundred feet, and a basal diameter of three to five feet or more. The bark is closely checked and dark-gray in color. The sapwood is very limited in amount, and the heartwood dark and close grained.

*Range* — California to Oregon.

*Use* — Finishing lumber, furniture and wagonwork.

### TANBARK OAK.

(*Q. densiflora* H. & L.)

A large evergreen tree usually preferring a moist soil. The bark is smoother than that of the black oak, lighter in color and contains much more tannin, hence it is highly prized for tanning purposes.

This tree bears immense quantities of acorns which are quite edible and have been used for food from time immemorial to the present day by the Indians of Northern California and Southern Oregon. The acorns are gathered in autumn, the kernels extracted and reduced to a flour which, being made into cakes and dried, keeps quite a long time. In fact some of the old Indian graves in Southern Oregon, on being opened, disclose some of these cakes still preserved while the remains of the departed brave, to whose comfort they were intended to minister while on the way to the "happy hunting ground," had crumbled into dust.

*Range*—Northern California and Southern Oregon.

*Use*—Cabinetwork, tanbark and fuel.

### CALIFORNIA LAUREL.

(*Umbellularia Californica* (H. & A.) Nutt.)

In dry localities, as in Eastern Oregon, this tree seldom exceeds twenty-five to thirty feet high by twelve to eighteen inches in diameter, but in moist situations, as in the upper Umpqua Valley, it attains a height of seventy-five to one hundred feet and a basal diameter of two and one-half to five feet. The tree is an evergreen. The wood is olive-brown in color and of such a high specific gravity that it will not float in water. This property of sinking in water is made use of by sawmill men for the purpose of improving the color of the wood; immersion in water for a few months causing it to acquire a darker hue. It is hard, compact and durable, and is highly valued for cabinetwork.

*Range*—California to Central Oregon, the best groves being found in Coos and Douglas counties.

*Use*—Inside finishing, furniture and cabinetwork.

### MOUNTAIN MAHOGANY.

(*Cercocarpus ledifolius* Nutt.)

Medium-sized evergreen trees, attaining a height of twenty to thirty feet, and a basal diameter of ten to twenty inches. It appears to be incapable of enduring either a very moist or very dry climate and flourishes best under subhumid conditions. It has a considerable altitudinal range, being found as high as six thousand to seven thousand feet in Eastern Oregon and Idaho. The bark is finely checked and the wood reddish, heavy and compact.

*Range*—California to Oregon and eastward to Idaho.

*Use*—Cabinetwork, charcoal, tool handles, etc.

### OREGON CRAB APPLE.

(*Malus rivularis* (Dougl.) Roem.)

Small, deciduous trees, usually thriving best in close proximity to the coast or in equally humid locations. Under favorable conditions it ranges in height from fifteen to thirty feet, and in diameter from six to twelve inches.

*Range*—Sonoma County, California, to Alaska.

*Use*—Fancy cabinetwork, etc.

### WESTERN HAW.

(*Crataegus Douglasii* Lindl.)

In dry situations this tree becomes dwarfed to shrublike proportions, but along stream banks or in regions of sufficient humidity it attains a height of twenty to forty feet and a diameter of six to twelve inches. The tree is quite thorny, the fruit edible, and the wood hard, compact, and suitable for many economic purposes.

*Range*—California to British Columbia.

*Use*—Fancy wood-turning, tool handles, etc.

### BITTER CHERRY.

(*Cerasus emarginata* Dougl.)

Sometimes only a shrub, but usually a small tree eight to twenty feet high and three to six inches in diameter. The wood is close grained, takes a high polish and is used to some extent in cabinetwork.

*Range*—California to British Columbia.

*Use*—Furniture, cabinetwork, etc.

### WOOLLYLEAF CHERRY.

(*C. mollis* Dougl.)

A much larger tree than the preceding, frequently attaining a height of fifty to sixty feet and a basal diameter of one to two feet. It is a rapid grower and thrives best in a subhumid climate. In altitudinal range it can be found from sea level to about four thousand feet elevation. The fruit of both this and the preceding is exceedingly bitter, yet when the cultivated cherry is grafted on to the stump of either of them by fruitgrowers, the tree

is not only healthier and hardier, but the fruit is found to excel in flavor that of the cultivated cherry when grown, under similar conditions, on its own stump.

*Range*—Northern California to British Columbia.

*Use*—Furniture and cabinetwork.

### WESTERN CHOKECHERRY.

(*C. demissa* Nutt.)

This cherry has about the same altitudinal range as the preceding, but is not so rapid a grower. In size it ranges from twenty to fifty feet and in diameter from five to twelve inches. The bark differs greatly from that of our other cherries, which somewhat resemble the bark of a birch while this resembles that of a beech. The fruit is abundant and edible.

*Range*—California to British Columbia.

*Use*—Furniture and cabinetwork. Bark is medicinal.

### OREGON MAPLE.

(*Acer macrophyllum* Pursh.)

This beautiful maple is as unrivaled among our deciduous trees as the Douglas spruce is among our coniferous trees in Oregon. It is not only the largest, most abundant, and most useful of our hardwood trees, but is unquestionably the finest shadetree as well. Being decidedly moisture-loving in habit, it is chiefly found along stream banks and river bottoms west of the Cascade Range in this state, and probably attains its best development about the upper Umpqua Valley, where it reaches eighty to one hundred and thirty feet in height and three to six feet in diameter. It ranges in altitude from sea level to about four thousand feet elevation. Occasionally trees of this species are found affected with crinkled growths or burls, thus producing the so-called "birds-eye maple," which is highly prized for veneering and fancy cabinetwork.

*Range*—California to British Columbia and eastward to Idaho.

*Use*—Furniture, cabinetwork, and fuel.

### VINE MAPLE.

(*A. circinatim* Pursh.)

A small, straggly, viny tree, more or less declined and frequently shrubby. Under favorable conditions it attains a height of ten to forty feet and a diameter of three to six inches. It favors a humid climate and ranges in altitude from sea level to about five thousand feet elevation.

*Range*—California to Alaska.

*Use*—Barrel hoops (when young), fuel, etc.

### BEARWOOD OR CHITTIMWOOD.

(*Rhamnus Purshiana* de C.)

Being about equally as moisture-loving as the last-named, this tree is almost wholly confined to the region west of the Cascade Range in this state. It ranges in height from twenty to sixty feet and in diameter from five to

twelve inches, and is more valuable for the medicinal properties of its bark than for the quality of its timber, which is fairly good. The bark (known medicinally as *Cascara sagrada*) was at one time held in such high esteem and such immense quantities of it were exported from this state that the species was threatened with speedy extermination, but a decline of about fifty per cent. in price has given the tree a renewed chance in the struggle for existence, while chronic medicine drinkers have doubtless betaken themselves to some more freely advertised medical cure-all.

*Range*—California to British Columbia.

*Use*—Wood for cabinetwork; bark medicinal.

### WESTERN DOGWOOD.
(*Cornus Nuttallii* Aud.)

Another moisture-loving tree that consequently only attains its best development west of the Cascade Range in this region, where it can be found varying in height from twenty-five to eighty feet, and in diameter from six to twenty inches. It is a very vigorous tree, blooming twice a year in this state, usually in April and September. In spring it is a very showy tree in the forest, owing to the great white involucres surrounding its flowers, and in autumn it is even more conspicuous, owing to the contrast between the bright red berries and the brilliant white involucres of its fall flowers. Its altitudinal range is considerably more limited than that of the vine maple, and extends only from sea level to about three thousand feet elevation. It has the hardest wood of all of our Oregon trees, and on this account it is valued for all purposes where an exceedingly hard wood is required.

*Range*—California to British Columbia.

*Use*—Furniture, wood-turning, cogs for water-wheels, etc.

### MADRONA.
(*Arbutus Menziesii* Pursh.)

Occurs generally throughout the state west of the Cascade Range, where it is to be found on moist slopes or along stream banks. It is a beautiful evergreen tree, with symmetrical branches, and large, coriaceous leaves, resembling those of the cultivated laurel, and is well adapted for lawn or ornamentation. Flowers in profuse racemes, white; berries dark-reddish and many-seeded. When young the bark is reddish-brown, shreddy and exfoliating, but becomes checked and firm on the mature tree. When fully seasoned the wood is very hard, dark and heavy.

*Range*—California to British Columbia.

*Use*—Furniture and fancy cabinetwork.

### SHRUBBY FRINGE ASH.
(*Fraxinus dipetala* H. & A.)

A small tree, rarely exceeding twenty-five feet in height by about five inches in diameter. It is not abundant anywhere in Oregon, but increases in quantity towards the southern part of the state. The leaflets are much

smaller than those of the Oregon ash, being usually one to two inches long, while the winged fruit is about one inch long.

*Range* — California to the Columbia River.

*Use* — Furniture, tool handles, etc.

### OREGON ASH.

(*F. Oregona* Nutt.)

Mostly confined to the westward of the Cascade Range in this state. It favors a mild temperature and a humid or subhumid climate and usually occurs as a medium-sized tree in the northern part of the state, but towards the south, particularly in Curry and Coos counties, it becomes a magnificent tree, ranging in height from seventy to one hundred and twenty feet by three to six feet in diameter. The leaflets are oblong-lanceolate, two to four inches long, and the winged fruit one to one and one-half inches long. The bark is smooth on the young tree but becomes rough and irregularly checked as the tree matures. The wood is firm, straight-grained, takes a a good polish, and is extensively used in every furniture factory in the state.

*Range* — California to the lower valley of Fraser River, British Columbia.

*Use* — Furniture, inside finishing, stair posts, etc.

## IF WE KNOW.

When the year has found its freedom from the bondage of the frost,
And when memories of winter in a tide of life are lost,
Then the heart awakes to answer Nature's impulse and rejoice
If we know the hidden meanings and the music of her voice.

There are voices in the tree-tops — we may hear them as we pass —
There are whisperings of summer in the springing of the grass;
There's a noble sweep of triumph where the hawk is on the wing,
And the perfume of the *orchard* is the spirit of the spring.

Oh, the pulsing warmth of waking, how it permeates the air —
'Tis the anodyne of hope, that steals the bitterness from care.
We may lay aside our burdens in the glory of our choice,
*If we win the heart of Nature and will hearken to her voice.*

ALBERT BIGELOW PAINE.

# ACKNOWLEDGMENTS.

Before closing this report we beg to acknowledge the many favors granted, and the assistance given. this board by others in carrying on its work. We realize that it would have been impossible to do the work that has been done without the hearty co-operation of others. Those to whom we are especially indebted for assistance, and to whom we wish our appreciation of their valuable aid are: Quarantine Officer Alexander Craw, of San Francisco, the Department of Agriculture at Washington, D. C., and experiment stations of the United States. To all local papers and the press throughout the state is due a great deal of praise for the earnestness with which they have assisted us in horticultural education, in placing before the public, in a true light, the results of our efforts in behalf of the fruit interests of the state, and to Henry E. Dosch, for editing and compiling this our report.

E. L. SMITH,
President.

# INDEX.

A



B



C

D.



E.



F

## L.



## M.



## N.



## O.



## P

T



W



*